CONSTRUCTION MANUAL

KITCHEN ADDITION FOR

SOUR LAKE ELEMENTARY SCHOOL

1055 TX-326. SOUR LAKE, TEXAS 77659

HARDIN/JEFFERSON ISD

520 W. Herring Sour Lake, TX 77659

Project #23005

The LaBiche
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REGISTERED ARCHITECT * TEXAS
JOHN H. LaBICHE
11592
STATE OF TX

1/2/25

SOUR LAKE KITCHEN ADDITION
HARDIN-JEFFERSON ISD

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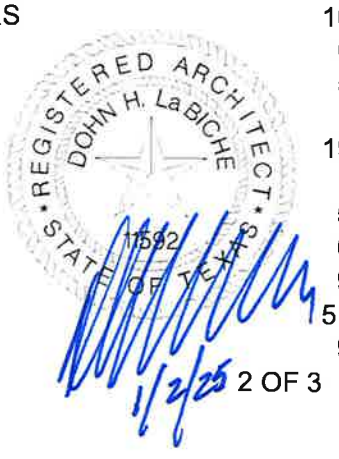

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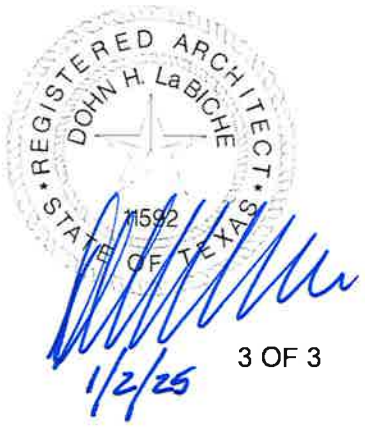

TEXAS STATUTORY PAYMENT BOND
BOND NO. _____

KNOW ALL MEN BY THESE PRESENTS:

THAT, _____, (hereinafter called the Principal), as Principal, and _____, a _____ organized and existing under the laws of the State of _____, licensed to do business in the State of Texas and admitted to write bonds, as surety, (hereinafter call the Surety), are held and firmly bound unto **Hardin-Jefferson ISD** (hereinafter call the Obligee), in the amount of **_____ DOLLARS ($_____)** for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally by this presents.

WHEREAS, the Principal has entered into a certain contract with the Obligee, dated the _____ day of _____, _____, for __renovation of Hamshire-Fannett ISD schools, which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall pay all claimants supplying labor and material to him or a subcontractor in the prosecution of the work provided for in said contract, then this obligation shall be null and void; otherwise to remain in full force and effect;

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the Texas Government Code and all liabilities on this bond shall be determined in accordance with the provisions, conditions and limitations of said Chapter to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, _____.

PRINCIPAL:

_____

By:_____
Name:_____
Title:_____

SURETY:

_____

By:_____
Name:_____
Title:_____

TEXAS STATUTORY PERFORMANCE BOND
BOND NO. _____

KNOW ALL MEN BY THESE PRESENTS:

THAT, _____, (hereinafter called the Principal), as Principal, and _____, a _____ organized and existing under the laws of the State of _____, licensed to do business in the State of Texas and admitted to write bonds, as surety, (hereinafter call the Surety), are held and firmly bound unto **Hardin-Jefferson ISD** (hereinafter call the Obligee), in the amount of **_____ DOLLARS ($_____)** for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally by this presents.

WHEREAS, the Principal has entered into a certain contract with the Obligee, dated the ____ day of _____, _____, for renovation of Hamshire-Fannett ISD schools, which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform the work in accordance with the plans, specifications and contract documents, then this obligation shall be null and void; otherwise to remain in full force and effect;

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the Texas Government Code and all liabilities on this bond shall be determined in accordance with the provisions, conditions and limitations of said Chapter to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, _____.

PRINCIPAL:

_____

By:_____
Name:_____
Title:_____

SURETY:

_____

By:_____
Name:_____
Title:_____

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Scope covered by the Contract Documents.
2. Work phases.
3. Work under other contracts.
4. Use of premises.
5. Owner's occupancy requirements.
6. Specification formats and conventions.

B. See Division 01 Section "Multiple Contract Summary" for division of responsibilities for the Work.

1.2 SCOPE COVERED BY CONTRACT DOCUMENTS

A. Project Identification: SOUR LAKE ELEMENTARY KITCHEN ADDITION

1. Project Location: 1055 TX-326, Sour Lake, TX 77659

B. Owner: HARDIN - JEFFERSON ISD, 520 W. Herring, Sour Lake, TX 77659
1. Owner's Representative: Kaleb Norris, Maintenance Director, (409) 748-9800

C. Architect: The LaBiche Architectural Group, Inc., 7999 Gladys Avenue, #101, Beaumont, Texas 77706.

D. The Scope consists of the following:

1. The Scope includes the partial demolition and new construction of the addition to the kitchen, and performance of demolition and construction services related to the project including all labor, materials, services and equipment as indicated in the Construction Documents.

E. Project will be constructed under a single prime contract.

1.3 USE OF PREMISES

A. General: Contractor shall have full use of premises for construction operations, including use of Project sites, during construction period. Contractor's use of premises

is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

B. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

C. Use of Site: Limit use of premises to areas within the Contract limits as indicated or as allowed by the Owner. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine constructions operations to areas indicated on the Floor Plan.

a. Limit site disturbance, including earthwork and clearing of vegetation, to 40 feet (12.2 m) beyond building perimeter; 10 feet (3 m) beyond surface walkways, patios, surface parking, and utilities less than 12 inches (300 mm) in diameter; 15 feet (4.5 m) beyond primary roadway curbs and main utility branch trenches; and 25 feet (7.6 m) beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area.

b. Work includes temporary fencing required to protect the site from intrusion by students, parents, employees and vendors visiting the site for normal school activities.

2. Owner Occupancy: Allow for Owner occupancy of adjacent school sites.
3. Driveways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

a. Schedule deliveries to minimize use of driveways and entrances.
b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.4 OWNER'S OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.

B. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
3. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of building.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

1.5 WORK RESTRICTIONS

A. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor air intakes.

1.6 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the 33 -division format and CSI/CSC's "Master Format" numbering system.

1. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012100 – ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

B. Types of allowances include the following:

1. Lump-sum allowances.

1.2 SELECTION AND PURCHASE

A. Purchase products and systems selected by Architect from the designated supplier.

1.3 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.4 INFORMATIONAL SUBMITTALS

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 LUMP-SUM ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials selected by Architect under allowance and shall include **taxes,** freight**,** and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

1.6 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.
2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Allowance No. 1: Lump-Sum Allowance: **Owners Contingency allowance for the sum of Fifty Thousand Dollars ($50,000.00) shall be included in the TOTAL BID PRICE.**

END OF SECTION 012100

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Section:

1. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1.3 SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use facsimile of form provided in the Project Manual.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:

    a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    b. Requested substitution will not adversely affect Contractor's construction schedule.
    c. Requested substitution has received necessary approvals of authorities having jurisdiction.
    d. Requested substitution is compatible with other portions of the Work.
    e. Requested substitution has been coordinated with other portions of the Work.
    f. Requested substitution provides specified warranty.
    g. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:

    a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    b. Requested substitution does not require extensive revisions to the Contract Documents.
    c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    d. Requested substitution will not adversely affect Contractor's construction schedule.
    e. Requested substitution has received necessary approvals of authorities having jurisdiction.
    f. Requested substitution is compatible with other portions of the Work.
    g. Requested substitution has been coordinated with other portions of the Work.
    h. Requested substitution provides specified warranty.
    i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

B. See Division 01 Section "Allowances" for procedural requirements for handling and processing allowances.

C. See Division 01 Section "Unit Prices" for administrative requirements for using unit prices.

1.2 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

1.3 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

    a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    c. Include costs of labor and supervision directly attributable to the change.
    d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

C. Proposal Request Form: Use AIA Document G709 for Proposal Requests.

1.4 ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.
2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 7 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has

changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.2 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Application for Payment forms with Continuation Sheets, Submittals Schedule and Contractor's Construction Schedule.
2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one-line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:

    a. Project name and location.
    b. Name of Architect.
    c. Architect's project number.
    d. Contractor's name and address.
    e. Date of submittal.

2. Submit draft of AIA Document G703 Continuation Sheets.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.

9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.3 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Times: Progress payments shall be submitted to Architect by the 23rd of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

D. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.

E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

    1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
    2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

F. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Schedule of unit prices.
5. Submittals Schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. List of Contractor's principal consultants.
8. Copies of building permits.
9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
10. Initial progress report.
11. Report of preconstruction conference.
12. Certificates of insurance and insurance policies.

I. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.

2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative provisions for coordinating demolition operations on Project including, but not limited to, the following:

1. Coordination Drawings.
2. Project meetings.
3. Requests for Interpretation (RFIs).

B. See Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.2 DEFINITIONS

A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

1.3 COORDINATION

A. Coordination: Coordinate demolition operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate demolition operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

1. Schedule demolition operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other demolition activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Demolition Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.
9. Project closeout activities.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

   a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   b. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Sheet Size: At least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
3. Number of Copies: Submit six opaque copies of each submittal. Architect will return four copies.
4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

1.5 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Pre-demolition Conference: Schedule a pre-demolition conference before starting demolition, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative demolition schedule.
    b. Phasing.
    c. Critical work sequencing and long-lead items.
    d. Designation of key personnel and their duties.
    e. Procedures for processing field decisions and Change Orders.
    f. Procedures for RFIs.
    g. Procedures for testing and inspecting.
    h. Procedures for processing Applications for Payment.
    i. Distribution of the Contract Documents.
    j. Submittal procedures.
    k. Preparation of Record Documents.
    l. Use of the premises.
    m. Work restrictions.
    n. Owner's occupancy requirements.
    o. Responsibility for temporary facilities and controls.
    p. Demolition waste management and recycling.
    q. Parking availability.
    r. Office, work, and storage areas.
    s. Equipment deliveries and priorities.
    t. First aid.
    u. Security.
    v. Progress cleaning.
    w. Working hours.

3. Minutes: Record and distribute meeting minutes.

1.6 REQUESTS FOR INTERPRETATION (RFIs)

A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.

1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:

1. Project name.
2. Date.
3. Name of Contractor.
4. Name of Architect.
5. RFI number, numbered sequentially.
6. Specification Section number and title and related paragraphs, as appropriate.
7. Drawing number and detail references, as appropriate.
8. Field dimensions and conditions, as appropriate.
9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
10. Contractor's signature.
11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.

C. Hard-Copy RFIs:

1. Identify each page of attachments with the RFI number and sequential page number.

D. Architect's Action: Architect will review each RFI, determine action required, and return it. Allow seven working days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for coordination information already indicated in the Contract Documents.
d. Requests for adjustments in the Contract Time or the Contract Sum.
e. Requests for interpretation of Architect's actions on submittals.
f. Incomplete RFIs or RFIs with numerous errors.

2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.
8. Identification of related Minor Change in the Work, Demolition Change Directive, and Proposal Request, as appropriate.
9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's Construction Schedule.
2. Submittals Schedule.
3. Daily construction reports.
4. Field condition reports.

B. See Division 01 Section "Payment Procedures" for submitting the Schedule of Values.

1.2 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

E. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

F. Major Area: A story of construction, a separate building, or a similar significant construction element.

1.3 SUBMITTALS

A. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Architect's final release or approval.

B. Contractor's Construction Schedule: Submit three opaque copies of initial schedule, large enough to show entire schedule for entire construction period.

1. Submit an electronic copy of schedule, using software indicated, on CD-R, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.

C. Daily Construction Reports: Submit three copies at monthly intervals.

D. Field Condition Reports: Submit three copies at time of discovery of differing conditions.

1.4 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.

2. Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
4. Startup and Testing Time: Include not less than seven days for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
4. Work Restrictions: Show the effect of the following items on the schedule:

a. Coordination with existing construction.
b. Limitations of continued occupancies.
c. Uninterruptible services.
d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.
f. Provisions for future construction.
g. Seasonal variations.
h. Environmental control.

5. Work Stages: Indicate important stages of construction for each major portion of the Work.

6. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

D. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate Actual Completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. See Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule.

C. See Division 01 Section "Quality Requirements" for submitting test and inspection reports.

D. See Division 01 Section "Closeout Procedures" for submitting warranties.

E. See Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.

F. See Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.

G. See Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Architect's responsive action.

B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Re-submittal Review: Allow 15 days for review of each re-submittal.

D. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
3. Include the following information on label for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name and address of Architect.
    d. Name and address of Contractor.
    e. Name and address of subcontractor.
    f. Name and address of supplier.
    g. Name of manufacturer.
    h. Submittal number or other unique identifier, including revision identifier.

        1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Location(s) where product is to be installed, as appropriate.
    l. Other necessary identification.

E. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.

F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

1. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.

G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review, received from sources other than Contractor.

1. Transmittal Form: Use AIA Document G810 or approved Contractor Transmittal Form.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked approved on Architect's Submittal review form attached at the end of this section.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Use only final submittals with mark indicating approval taken by Architect.

K. From AIA Document A201-2017 - General Conditions of the Contract for Construction: **§ 3.12.10.3** The Architect's review of Contractor's submittals will be limited to one (1) examination of an initial submittal, and one (1) examination of a resubmittal. The Architect's review of additional submittals will be made only with the consent of the Owner after notification by the Architect. The Owner shall be entitled to deduct from the Contract Sum amounts paid to the Architect for evaluation of such additional resubmittals.

1.4 CONTRACTOR'S USE OF ARCHITECT'S CAD FILES

A. General: At Contractor's written request, copies of Architect's CAD files will be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:

1. Approval by the Architect and Owner.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's written recommendations.
    b. Manufacturer's product specifications.
    c. Manufacturer's installation instructions.
    d. Manufacturer's catalog cuts.
    e. Wiring diagrams showing factory-installed wiring.
    f. Printed performance curves.
    g. Operational range diagrams.
    h. Compliance with specified referenced standards.
    i. Testing by recognized testing agency.

4. Number of Copies: Submit seven copies of Product Data, unless otherwise indicated. Architect will return five copies. Mark up and retain two returned copies as Project Record Documents.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

    a. Dimensions.
    b. Identification of products.
    c. Fabrication and installation drawings.
    d. Roughing-in and setting diagrams.
    e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    f. Shopwork manufacturing instructions.
    g. Templates and patterns.
    h. Schedules.
    i. Notation of coordination requirements.
    j. Notation of dimensions established by field measurement.
    k. Relationship to adjoining construction clearly indicated.
    l. Seal and signature of professional engineer if specified.
    m. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
3. Number of Copies: Submit six opaque (bond) copies of each submittal. Architect will return one copy.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of appropriate Specification Section.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project Record Sample.

E. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location.

1. Number of Copies: Submit seven copies of product schedule or list, unless otherwise indicated. Architect will return five copies.

F. Submittals Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."

G. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."

H. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."

I. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.

1. Number of Copies: Submit three copies of subcontractor list, unless otherwise indicated. Architect will return two copies.

2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.

1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Architect will not return copies.
2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
3. Test and Inspection Reports: Comply with requirements specified in Division 01 Section "Quality Requirements."

B. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."

C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."

D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

H. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

I. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

L. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.

M. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

N. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

O. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

P. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."

Q. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

R. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer’s.

S. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Statement on condition of substrates and their acceptability for installation of product.
2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.

T. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

U. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Architect.

1. Architect will not review submittals that include MSDSs and will return them for resubmittal.

2.3 DELEGATED DESIGN

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

1. See sample of Architect’s Shop Drawing Review Sheet at the end of this section.

C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

Submittals not required by the Contract Documents may not be reviewed and may be discarded.

The LaBiche
ARCHITECTURAL GROUP, INC.

Dohn H. LaBiche, FAIA - Principal
Greg Wall, AIA - Principal

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Beaumont, Texas 77706
(409) 860-0197 • Fax (409) 860-0198

SHOP DRAWING REVIEW

Project Name: XX

Project Number: XX

Submittal For: **XX**

	No Exception		Exceptions Noted		Rejected
	Revise & Resubmit		Submit Specified Item		

NOTE:
Our checking is only to determine general conformance with the design concept of the project and general compliance with the Contract Documents. The Contractor is solely responsible for confirming and correlating dimensions at the job site; for information which pertains to fabrication processes or construction techniques, and for coordinating the work of all trades. Our checking of shop drawings and submittals shall not relieve the Contractor of responsibility for deviation from the requirements of the Contract Documents nor for errors or emissions in the shop drawings and submittals.

By: Date:

Remarks:

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
2. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. See Divisions 02 through 49 Sections for specific test and inspection requirements.

1.2 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate the actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.

D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.4 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.5 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those

operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed, unless otherwise indicated.

J. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 02 through 49.

1.6 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which situations tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.7 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

B. Special Tests and Inspections: Conducted by a qualified testing agency required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
2. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

AA	Aluminum Association, Inc. (The)
AAADM	American Association of Automatic Door Manufacturers
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists (The)
ABAA	Air Barrier Association of America
ABMA	American Bearing Manufacturers Association
ACI	ACI International (American Concrete Institute)
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies, Inc. (The)
AF&PA	American Forest & Paper Association
AGA	American Gas Association
AGC	Associated General Contractors of America (The)
AHA	American Hardboard Association (Now part of CPA)
AHAM	Association of Home Appliance Manufacturers

AI	Asphalt Institute
AIA	American Institute of Architects (The)
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALCA	Associated Landscape Contractors of America (Now PLANET - Professional Landcare Network)
ALSC	American Lumber Standard Committee, Incorporated
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
AOSA	Association of Official Seed Analysts, Inc.
APA	Architectural Precast Association
APA	APA - The Engineered Wood Association
APA EWS	APA - The Engineered Wood Association; Engineered Wood Systems
API	American Petroleum Institute
ARI	Air-Conditioning & Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	ASME International (The American Society of Mechanical Engineers International)
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International (American Society for Testing and Materials International)
AWCI	AWCI International (Association of the Wall and Ceiling Industry International)

AWCMA	American Window Covering Manufacturers Association (Now WCSC)
AWI	Architectural Woodwork Institute
AWPA	American Wood-Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BICSI	BICSI
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International)
BISSC	Baking Industry Sanitation Standards Committee
CCC	Carpet Cushion Council
CDA	Copper Development Association
CEA	Canadian Electricity Association
CFFA	Chemical Fabrics & Film Association, Inc.
CGA	Compressed Gas Association
CIMA	Cellulose Insulation Manufacturers Association
CISCA	Ceilings & Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CRRC	Cool Roof Rating Council
CPA	Composite Panel Association
CPPA	Corrugated Polyethylene Pipe Association
CRI	Carpet & Rug Institute (The)
CRSI	Concrete Reinforcing Steel Institute

CSA	Canadian Standards Association
CSA	CSA International (Formerly: IAS - International Approval Services)
CSI	Cast Stone Institute
CSI	Construction Specifications Institute (The)
CSSB	Cedar Shake & Shingle Bureau
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute)
DHI	Door and Hardware Institute
EIA	Electronic Industries Alliance
EIMA	EIFS Industry Members Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ESD	ESD Association
FIBA	Federation Internationale de Basketball (The International Basketball Federation)
FIVB	Federation Internationale de Volleyball (The International Volleyball Federation)
FM Approvals	FM Approvals
FM Global	FM Global (Formerly: FMG - FM Global)
FMRC	Factory Mutual Research (Now FM Global)
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.
FSA	Fluid Sealing Association
FSC	Forest Stewardship Council
GA	Gypsum Association
GANA	Glass Association of North America
GRI	(Now GSI)

GS	Green Seal
GSI	Geosynthetic Institute
HI	Hydraulic Institute
HI	Hydronics Institute
HMMA	Hollow Metal Manufacturers Association (Part of NAAMM)
HPVA	Hardwood Plywood & Veneer Association
HPW	H. P. White Laboratory, Inc.
IAS	International Approval Services (Now CSA International)
IBF	International Badminton Federation
ICEA	Insulated Cable Engineers Association, Inc.
ICRI	International Concrete Repair Institute, Inc.
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IESNA	Illuminating Engineering Society of North America
IEST	Institute of Environmental Sciences and Technology
IGCC	Insulating Glass Certification Council
IGMA	Insulating Glass Manufacturers Alliance
ILI	Indiana Limestone Institute of America, Inc.
ISO	International Organization for Standardization
ISSFA	International Solid Surface Fabricators Association
ITS	Intertek Testing Service NA
ITU	International Telecommunication Union
KCMA	Kitchen Cabinet Manufacturers Association
LMA	Laminating Materials Association (Now part of CPA)

LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturers Association
MFMA	Maple Flooring Manufacturers Association, Inc.
MFMA	Metal Framing Manufacturers Association, Inc.
MH	Material Handling (Now MHIA)
MHIA	Material Handling Industry of America
MIA	Marble Institute of America
MPI	Master Painters Institute
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International (National Association of Corrosion Engineers International)
NADCA	National Air Duct Cleaners Association
NAGWS	National Association for Girls and Women in Sport
NAIMA	North American Insulation Manufacturers Association
NBGQA	National Building Granite Quarries Association, Inc.
NCAA	National Collegiate Athletic Association (The)
NCMA	National Concrete Masonry Association
NCPI	National Clay Pipe Institute
NCTA	National Cable & Telecommunications Association
NEBB	National Environmental Balancing Bureau
NECA	National Electrical Contractors Association
NeLMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association

NFHS	National Federation of State High School Associations
NFPA	NFPA (National Fire Protection Association)
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NLGA	National Lumber Grades Authority
NOFMA	NOFMA: The Wood Flooring Manufacturers Association (Formerly: National Oak Flooring Manufacturers Association)
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	NSF International (National Sanitation Foundation International)
NSSGA	National Stone, Sand & Gravel Association
NTMA	National Terrazzo & Mosaic Association, Inc. (The)
NTRMA	National Tile Roofing Manufacturers Association (Now TRI)
NWWDA	National Wood Window and Door Association (Now WDMA)
OPL	Omega Point Laboratories, Inc. (Now ITS)
PCI	Precast/Prestressed Concrete Institute
PDCA	Painting & Decorating Contractors of America
PDI	Plumbing & Drainage Institute
PGI	PVC Geomembrane Institute
PLANET	Professional Landcare Network (Formerly: ACLA - Associated Landscape Contractors of America)
PTI	Post-Tensioning Institute
RCSC	Research Council on Structural Connections

RFCI	Resilient Floor Covering Institute
RIS	Redwood Inspection Service
SAE	SAE International
SDI	Steel Deck Institute
SDI	Steel Door Institute
SEFA	Scientific Equipment and Furniture Association
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SGCC	Safety Glazing Certification Council
SIA	Security Industry Association
SIGMA	Sealed Insulating Glass Manufacturers Association (Now IGMA)
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SMPTE	Society of Motion Picture and Television Engineers
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division)
SPIB	Southern Pine Inspection Bureau (The)
SPRI	Single Ply Roofing Industry
SSINA	Specialty Steel Industry of North America
SSPC	SSPC: The Society for Protective Coatings
STI	Steel Tank Institute
SWI	Steel Window Institute
SWRI	Sealant, Waterproofing, & Restoration Institute
TCA	Tile Council of America, Inc.

TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TMS	The Masonry Society
TPI	Truss Plate Institute, Inc.
TPI	Turfgrass Producers International
TRI	Tile Roofing Institute
UL	Underwriters Laboratories Inc.
UNI	Uni-Bell PVC Pipe Association
USAV	USA Volleyball
USGBC	U.S. Green Building Council
USITT	United States Institute for Theatre Technology, Inc.
WASTEC	Waste Equipment Technology Association
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association (Now WCSC)
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association)
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association)
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California)
WIC	Woodwork Institute of California (Now WI)
WMMPA	Wood Moulding & Millwork Producers Association
WSRCA	Western States Roofing Contractors Association
WWPA	Western Wood Products Association

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

BOCA	BOCA International, Inc. (See ICC)

IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials (See ICC)
ICBO ES	ICBO Evaluation Service, Inc. (See ICC-ES)
ICC	International Code Council
ICC-ES	ICC Evaluation Service, Inc.
SBCCI	Southern Building Code Congress International, Inc. (See ICC)
UBC	Uniform Building Code (See ICC)

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

CE	Army Corps of Engineers
CPSC	Consumer Product Safety Commission
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FDA	Food and Drug Administration
GSA	General Services Administration
HUD	Department of Housing and Urban Development
LBL	Lawrence Berkeley National Laboratory
NCHRP	National Cooperative Highway Research Program (See TRB)

NIST	National Institute of Standards and Technology
OSHA	Occupational Safety & Health Administration
PBS	Public Building Service (See GSA)
PHS	Office of Public Health and Science
RUS	Rural Utilities Service (See USDA)
SD	State Department
TRB	Transportation Research Board
USDA	Department of Agriculture
USPS	Postal Service

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list.

ADAAG	Americans with Disabilities Act (ADA) Architectural Barriers Act (ABA)
CFR	Code of Federal Regulations
DOD	Department of Defense Military Specifications and Standards
DSCC	Defense Supply Center Columbus (See FS)
FED-STD	Federal Standard (See FS)
FS	Federal Specification
FTMS	Federal Test Method Standard (See FS)
MIL	(See MILSPEC)
MIL-STD	(See MILSPEC)
MILSPEC	Military Specification and Standards
UFAS	Uniform Federal Accessibility Standards

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

CBHF	State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation
CCR	California Code of Regulations
CPUC	California Public Utilities Commission
TFS	Texas Forest Service Forest Resource Development

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. See Division 01 Section "Execution" for progress cleaning requirements.

C. See Divisions 02 through 49 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.

1.2 DEFINITIONS

A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weather tight; exterior walls are insulated and weather tight; and all openings are closed with permanent construction or substantial temporary closures.

1.3 USE CHARGES

A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.

B. Water Service: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

C. Electric Power Service: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. NOT USED

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Division 01 Section "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

1. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.

E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

F. Heating and Cooling : Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed

construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

H. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.

I. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1. Install electric power service overhead, unless otherwise indicated.
2. Connect temporary service to Owner's existing power source, as directed by Owner.

J. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

K. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office.

1. Provide additional telephone lines for the following:

a. Provide a dedicated telephone line for each facsimile machine and computer in each field office.

2. At each telephone, post a list of important telephone numbers including police and fire departments, Contractor's home office, Architect's office, Owner's office and security office, Principal subcontractors' field and home offices.
3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

L. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail in field office.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare sub grade and install sub base and base for temporary roads and paved areas according to Division 31 Section "Earth Moving."
3. Recondition base after temporary use, including removing contaminated material, re-grading, proof rolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 32 Section "Asphalt Paving."

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

G. Project Identification and Temporary Signs: Provide Project identification and other signs as indicated at the end of this section. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.

1. Provide temporary, directional signs for construction personnel and visitors.
2. Maintain and touchup signs so they are legible at all times.

H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 01 Section "Execution" for progress cleaning requirements.

I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

C. Storm Water Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and sub grade construction to prevent flooding by runoff of storm water from heavy rains.

D. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

F. Site Enclosure Fence: Before construction operations begin and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.

G. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary

facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. See Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.

C. See Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.3 SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: type written letter on company stationary.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified material or product cannot be provided.
b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
j. Cost information, including a proposal of change, if any, in the Contract Sum.
k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

a. Form of Acceptance: Change Order.

b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

B. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
b. Use product specified if Architect cannot make a decision on use of a comparable product request within time allocated.

C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

B. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.

10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.

    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

A. Timing: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

B. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
2. Requested substitution does not require extensive revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.

2.3 COMPARABLE PRODUCTS

A. Conditions: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:

1. Demolition layout.
2. Field surveying.
3. General installation of products.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed demolition.
7. Correction of the Work.

B. See Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 SUBMITTALS

A. Certificates: Submit certificate signed by professional engineer certifying that the elevations comply with requirements.

B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.3 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor employed by Fittz & Shipman Engineers, Beaumont, Texas, who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. A final survey following completion of regrading the site as directed by the Civil Drawings is required for substantial Completion. The survey requires notification by the Contractor and is paid for by the Architect. Should the survey show deviation from the Construction Documents, Contractor shall correct deviations and will be responsible for the cost of an additional survey to confirm compliance with Construction Documents. Payment of retainage is dependent upon the final survey corrections at the sole approval of the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of site improvements, utilities, and other demolition indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other demolition affecting the Work.

1. Before demolition, verify the location and points of connection of utility services.

B. Existing Utilities: The existence and location of underground and other utilities and demolition indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other demolition affecting the Work.

1. Before demolition, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by demolition. Coordinate with authorities having jurisdiction.

B. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to

Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 DEMOLITION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 INSTALLATION (Not Used)

3.5 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

H. During handling and installation, clean and protect demolition in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed demolition as frequently as necessary through the remainder of the demolition period.

J. Limiting Exposures: Supervise demolition operations to assure that no part of the demolition, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the demolition period.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

   1. Section 024116 "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
   2. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed.

1.4 INFORMATIONAL SUBMITTALS

A. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

B. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

D. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Inspection procedures.
2. Final cleaning.

B. See Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.

C. See Divisions 02 through 49 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.2 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.
3. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities.
4. Terminate and remove temporary facilities from Project site, construction tools, and similar elements.
5. Complete final cleaning requirements.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of demolition.
1. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by demolition activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Remove tools, construction equipment, machinery, and surplus material from Project site.

B. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Emergency manuals.
2. Operation manuals for systems, subsystems, and equipment.
3. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.

B. See Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 SUBMITTALS

A. Manual: Submit one copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.

1. Correct or modify each manual to comply with Architect's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Architect's comments.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page, table of contents, and manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name, address, and telephone number of Contractor.
6. Name and address of Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for type of emergency, emergency instructions, and emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component for fire, flood, water leak, power failure, water outage, equipment failure and chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include instructions on stopping, shutdown instructions for each type of emergency, operating instructions for conditions outside normal operating limits, and required sequences for electric or electronic systems.

2.3 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.

4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment:

D. Maintenance Procedures: Include test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions, and demonstration and training videotape if available, that detail essential maintenance procedures:

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals.

F. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record specifications.
3. Record Product Data.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
1. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal:
1) Submit PDF electronic files of scanned record prints and one set of file prints.
2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:
1) Submit PDF electronic files of scanned Record Prints and two sets of file prints.

B. Record Specifications: Submit annotated PDF electronic files and two paper copies of Project's Specifications, including addenda and Contract modifications.

1.3 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made following Architect's written orders.
k. Details not on the original Contract Drawings.
l. Field records for variable and concealed conditions.
m. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file with comment function enabled.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Architect for resolution.
4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.

C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Format: Annotated PDF electronic file with comment function enabled.
2. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name

each file with the sheet identification. Include identification in each digital data file.

3. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect.
    e. Name of Contractor.

1.4 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

B. Format: Submit record specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

1.5 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

C. Format: Submit Record Product Data as scanned PDF electronic file(s) of marked-up paper copy of Product Data.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.6 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 024116 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of buildings and site improvements.
2. Removing below-grade construction.
3. Disconnecting, capping or sealing, and abandoning in-place site utilities.
4. Salvaging items for reuse by Owner.

1.2 MATERIALS OWNERSHIP

A. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection and, for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of building demolition with starting and ending dates for each activity.

C. Inventory of items to be removed and salvaged.

D. Pre-demolition photographs or video.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.4 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

D. Pre-demolition Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.

1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.

a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. Owner assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
1. If unknown materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Sale of removed items or materials is permitted.

F. Arrange demolition schedule so as not to interfere with operations of adjacent occupied buildings.

PART 2 - PRODUCTS[(Not Used)]

2.1 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.

B. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.

1. Contractor will arrange to shut off indicated utilities as required.
2. Arrange to shut off indicated utilities with utility companies.
3. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
4. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
5. Do not start demolition work until utility disconnecting and sealing have been completed.

C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.4 DEMOLITION

A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations.

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain fire watch during and for at least 4 hours after flame cutting operations.
3. Maintain adequate ventilation when using cutting torches.
4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
5. Architect will engage Surveyor to locate all drilled footings located inside building footprint during demolition. Contractor shall notify and coordinate survey with Architect’s Civil Engineering firm.

B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.

C. Explosives: Use of explosives is not permitted.

D. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

E. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

F. Demolish foundation walls and other below-grade construction.

1. Remove below-grade construction, including basements, foundation walls, and footings, to at least 48 inches below grade.

G. Existing Utilities: Demolish existing utilities and below-grade utility structures within 5 feet outside footprint indicated for new construction. Cut utilities flush with grade.

H. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Section 312000 "Earth Moving."

I. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

J. Promptly repair damage to adjacent buildings caused by demolition operations.

3.5 CLEANING

A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction. See Section 017419 "Construction Waste Management and Disposal" for recycling and disposal of demolition waste.

B. Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION 024116

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Shoring, bracing, and anchoring.

1.2 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.
3. Form ties.
4. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301 (ACI 301M).

    a. Location of construction joints is subject to approval of the Architect.

3. Indicate location of waterstops.

PART 2 - PRODUCTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

a. Plywood, metal, or other approved panel materials.
b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
1) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 RELATED MATERIALS

A. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

C. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

D. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

E. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301 (ACI 301M).

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M) and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:
   1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch (6 mm).

D. Construct forms tight enough to prevent loss of concrete mortar.

   1. Minimize joints.
   2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

   1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
   2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

   1. Provide and secure units to support screed strips.
   2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

   1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
   2. Locate temporary openings in forms at inconspicuous locations.

Retain one of two options in first paragraph below. ACI 301 (ACI 301M) requires chamfers unless otherwise specified.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches (305 mm).

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings.

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
4. Clean embedded items immediately prior to concrete placement.

3.3 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 (ACI 318M) and ACI 301 (ACI 301M) for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. Plan sequence of removal of shores and re-shore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of the Architect.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1. Reinforcement to Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M

B. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

C. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420) deformed.

B. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch (25 mm), not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318 (ACI 318M).

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches (610 mm), whichever is greater.
2. Stagger splices in accordance with ACI 318 (ACI 318M).
3. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches (305 mm).

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.

4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117 (ACI 117M).

3.5 FIELD QUALITY CONTROL

A. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART I – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions, apply to this section.
B. Reference structural drawings for additional notes and details reference cast-in-place concrete.

1.2 SUMMARY

A. Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures and finishes

1.3 RELATED SECTIONS

A. Coordinate Work of Section with work of other sections, including Division 01 Sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.4 SUBMITTALS

A. Product Data: Submit Manufacturer’s Technical Data, installation instructions and recommendations for each product. Include data substantiating that materials comply with specified requirements.

    1. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, curing compounds and others as requested by Architect/Engineer.

B. Design Mixtures: For each concrete mixture.

C. Shop Drawings: Submit for reinforcement, prepared by Professional Engineer registered in the State of Texas for fabrication, bending and placement of concrete reinforcement. Comply with ACI SP-66(88), “ACI Detailing Manual”, showing bar schedules, stirrup spacing, and diagrams of bent bars and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

D. Laboratory test reports for concrete materials and mix design test.

E. Materials Certificates in lieu of Material Laboratory Test Reports when permitted by Architect/Engineer. Materials Certificates shall be signed by Manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements, Provide certification from admixtures manufacturers that chloride content complies with specification requirements,

1.5 QUALITY ASSURANCE

A. This section outlines minimum standards and requirements. Refer to the Structural Drawings for additional requirements. In the event of conflict, information on Structural Drawings shall take precedence. Bring all conflicts and discrepancies between documents to the attention of the Architect and Engineer and do not work until such conflicts and discrepancies are clarified and corrected.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete and products and that complies with ASTM C 94/C 94M requirements for production facilities and equipments.

   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities"

C. ACI Publications: Comply with the following rules unless modified by requirements in the Contract Documents:

   1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials"

PART II - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet

D. Bar Supports: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic or pre-cast concrete according to CRSI's "Manual of Standard Practice"

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementituous materials, of the same type, brand and source, throughout the Project:

   1. Portland cement: ASTM C 150, Type I / II. Supplement with the following

      (a) Fly Ash: ASTM C 618, Class F, unless noted otherwise, no more than 15% fly ash by weight

B. Normal-Weight Aggregates: ASTM C 33, graded, 1½" (38mm) and ¾" (19mm) nominal maximum coarse-aggregate size.

C. Water: ATM C 94/C 94M and potable.

D. Air-Entraining Admixture: ASTM C 260

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride

   1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A
   2. Retarding Admixture: ASTM C 494/C 494M, Type B
   3. Water-Reducing and Retarding Admixtures: ASTM C 494/C 494M, Type D
   4. High-Range, Water-Reducing Admixtures: ASTM C 494/C 494M, Type F
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II

2.4 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A, or polyethylene sheet, ASTM D 4397, not less than 15 mils (0.381mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
B. Reference 072660 Below-Slab Vapor Barrier.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yard (305g/sq.m) when dry

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: potable

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering

G. Clear, Solvent-borne, Membrane-Forming Curing Compound: ASTM C 1315, Type 1, Class A

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A

I. Contractor use caution to review curing methods and chemicals with manufacturer of floor finish material to prevent compatibility issues with surface adhesion or reactions to adhesives.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Join-Filler Strips: ASTM D 1751, asphalt-saturated cellulose fiber

2.7 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301

B. Proportion normal-weight concrete mixtures as follows:

1. Minimum Compressive Strength: 2500 psi at 28 days for footing; 3000 psi at 28 days for all other concrete
2. Maximum-Water-Cementitious Material Ratio: 0.45
3. Slump Limit: 4” (100mm) plus or minus 1”(25mm)
4. Air Content: 5.5 % plus or minus 1.5% at point of delivery for 1 ½” (38mm) nominal maximum aggregate size.
5. Air Content: No entrained air for troweled finished floors

2.8 FABRICATING REINFORCEMENTS

A. Fabricating steel reinforcement according to CRSI’s “Manual of Standard Practice”

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch mix and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 ºF (30 and 32 ºC), reduce mixing and delivery time from 1.5 hours to 75 minutes; when air temperature is above 90 ºF (32 ºC), reduce mixing and delivery time to 60 minutes.

PART III – EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace and maintain formwork according to ACI 301 to support vertical, lateral, static and dynamic load and construction loads that might be applied until structure can support such loads

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation and position indicated within tolerance limits of ACI 117

C. Chamfer exterior corners and edges of permanently exposed concrete

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded

3.3 VAPOR RETARDERS

A. Plastic Vapor Retarder: Place, protect and repair vapor retarders according to ASTM E 1643 and manufacturer’s written instructions.

1. Lap joints 6” (150mm) and seal with manufacturer’s recommended tape

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI’s “Manual of Standard Practice” for placing reinforcement

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete

3.5

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect

C. Contraction joints in Slabs-on-Grade: Form weakened plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least ¼ of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8” (3.2mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saw equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8” (3.2mm) wide joints into concrete when cutting action will not tear, abrade or otherwise damage surface and before concrete develops random contraction cracks

D. Isolation Joints in Slab-on-Grade: After removing formwork, install joint0filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams and other locations as indicated

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement and embedded items is complete and that required inspections have been performed

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated on architects slab plan. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301

C. Cold-Weather Placement: Comply with ACI 306.1

D. Hot-Weather Placement: Comply with ACI 301

3.7 FINISHED FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish or to be covered with a coating or covering material applied directly to concrete

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part Portland cement to 1.5 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours

3. Cork-Floated Finish: Wet concrete surfaces and apply stiff grout. Mix 1 part Portland cement and 1-part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with cork float.

D. Related Unformed Surfaces: At top of walls, horizontal offsets and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.8 FINISHING FLOORS AND SLAB

A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms or rakes to produce a profile amplitude of 1/4” (6mm) in 1 direction.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Re-straighten, cut down high spots and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and

appearance. Grind smooth any surface defects and that would telegraph through applied coatings and floor coverings.

1. Apply trowel finish to surfaces indicated, exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint or another thin-film-finish coating system.

2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding 10’ (3.05m) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8”

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps and elsewhere as indicated.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 309.1 for cold weather protection and ACI 301 for hot weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1kg/sq. m x h) before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding and bull-floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in the widest practicable width, with sides and ends lapped at least 12” (300mm) and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

(a) After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing

compound manufacturer unless manufacturer certifies curing compound will not interfere with binding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports

1. Testing Services: Tests shall be performed according to ACI 301

END OF SECTION

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Lintels.
3. Brick.
4. Mortar and grout materials.
5. Reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Accessories.
9. Mortar and grout mixes.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For reinforcing steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R.

C. Samples: For each type and color of exposed masonry unit and colored mortar.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product and for masonry units, include data on material properties and material test reports substantiating compliance with requirements.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for typical exterior wall in sizes approximately 48 inches (1219 mm) long by full wall height by full thickness.

1.6 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 ft. (6 m) vertically and horizontally of a walking surface.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ACM Chemistries.
    b. Euclid Chemical Company (The); an RPM company.
    c. GCP Applied Technologies Inc.
    d. Master Builders Solutions.
    e. Moxie International.

C. CMUs: ASTM C90, normal weight.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3050 psi (21.0 MPa).

2.3 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength of not less than that of CMUs.

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 032000 "Concrete Reinforcing," and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: hollow brick complying with ASTM C652, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) Grade SW, Type HBS

1. Manufacturers: Subject to compliance with requirements, [provide products by the following:

    a. Acme Brick Company.
    b. Cherokee Brick

c. Yankee Hill Brick
d. Glen Gery Brick
e. Sioux City Brick
f. Summit Brick
g. Lakewood Brick
h. Pacific Clay Brick

i.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi .
3. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested in accordance with ASTM C67/C67M.
4. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
5. Size (Actual Dimensions) King size: 9-5/8”L x 2-5/8”H x 2-3/4” thru the wall

C. Building (Common) Brick: ASTM C62, Grade SW.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.68 MPa).
2. Size (Actual Dimensions): King size: 9-5/8”L x 2-5/8”H x 2-3/4” thru the wall

D. Hollow Brick: ASTM C652, Grade SW Class H40V (void areas between 25 and 40 percent of gross cross-sectional area, Type HBX

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Argos USA LLC.
b. Cemex S.A.B. de C.V.
c. Fairborn Cement Company.
d. Federal White Cement, Ltd.
e. Holcim (US) Inc.
f. Lafarge North America Inc.
g. Lehigh Hanson; HeidelbergCement Group.

h. Lehigh White Cement Company.
i. Quikrete; The QUIKRETE Companies, LLC.
j. Sakrete; CRH Americas, Oldcastle APG.

D. Colored Cement Products: Packaged blend made from masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Argos USA LLC.
2) Cemex S.A.B. de C.V.
3) Fairborn Cement Company.
4) Holcim (US) Inc.
5) Lafarge North America Inc.
6) Lehigh Hanson; HeidelbergCement Group.

E. Preblended Dry Mortar Mix: Packaged blend made from masonry cement, sand, mortar pigments, water repellents, and admixtures and complying with ASTM C1714/C1714M.

1. Preblended Dry Masonry Cement Mortar Mix

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Amerimix is a trademark of Bonsal American, an Oldcastle company.
2) SPEC MIX, LLC.

F. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6.4 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.

G. Aggregate for Grout: ASTM C404.

H. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C1384, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Euclid Chemical Company (The); an RPM company.
    b. GCP Applied Technologies Inc.

J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. ACM Chemistries.
    b. Euclid Chemical Company (The); an RPM company.
    c. GCP Applied Technologies Inc.
    d. Master Builders Solutions.

K. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).

B. Masonry-Joint Reinforcement, General: ASTM A951/A951M.

1. Interior Walls: Mill-galvanized carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
3. Wire Size for Side Rods: 0.187-inch (4.76-mm) diameter.
4. Wire Size for Cross Rods: 0.187-inch (4.76-mm) diameter.
5. Wire Size for Veneer Ties: 0.187-inch (4.76-mm) diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (406 mm) o.c.
7. Provide in lengths of not less than 10 ft. (3 m), with prefabricated corner and tee units.

C. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder or truss type with single pair of side rods.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Hohmann & Barnard, Inc.
    b. Wire-Bond.

D. Masonry-Joint Reinforcement for Multiwythe Masonry:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Heckmann Building Products, Inc.
    b. Hohmann & Barnard, Inc.
    c. Wire-Bond.
2. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch (1.6 mm) and maximum vertical adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.7 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
2. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (102 mm) wide.

1. Wire: Fabricate from 3/16-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.

D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-) diameter, [hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.

E. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (10-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

F. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

G. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf (445 N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.6 mm).
2. Fabricate wire ties from [0.187-inch- (4.76-mm-) diameter, hot-dip galvanized-steel wire unless otherwise indicated.
3. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie and washer at face of insulation.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) FERO Corporation.
        2) Hohmann & Barnard, Inc.
        3) PROSOCO, Inc.
        4) Wire-Bond.

4. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. Use self-adhering tape to seal penetration behind anchor plate.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Hohmann & Barnard, Inc.
        2) Wire-Bond.

5. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation with factory-installed gasketed washer to seal at face of insulation and sheathing.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Heckmann Building Products, Inc.
        2) Hohmann & Barnard, Inc.
        3) Rodenhouse Inc.

4) Wire-Bond.

6. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83 mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.

2.8 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 40 mil (1.0 mm) min.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Advanced Building Products Inc.
2) Carlisle Coatings & Waterproofing Inc.
3) Fiberweb, a brand of Clark/Hammerbeam Corp.
4) GCP Applied Technologies Inc.
5) Heckmann Building Products, Inc.
6) Hohmann & Barnard, Inc.
7) Polyguard Products, Inc.
8) W. R. Meadows, Inc.
9) Williams Products, Inc.
10) Wire-Bond.
11) York Manufacturing, Inc.

2. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 40 mil (1.0 mm).

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) DuPont de Nemours, Inc.
2) GCP Applied Technologies Inc.
3) Protecto Wrap Company.
4) Raven Industries, Inc.
5) Wire-Bond.

3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Hohmann & Barnard, Inc.
        2) Hyload; IKO Industries, Inc.
        3) Mortar Net Solutions.
        4) Wire-Bond.

    b. Monolithic Sheet: Elastomeric thermoplastic flashing, 40 mil (1.0 mm) thick.
    c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 25 mil (0.64 mm) thick, with a 15-mil- (0.38-mm-) thick coating of adhesive.

        1) Color: Black.

B. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

D. Termination Bars for Flexible Flashing: Stainless steel bars 0.075 inch by 1 inch (1.90 mm by 25 mm).

2.9 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from[styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vents: Use the following unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Advanced Building Products Inc.
2) Heckmann Building Products, Inc.
3) Hohmann & Barnard, Inc.
4) Mortar Net Solutions.
5) Wire-Bond.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Mortar Deflector: Strips, full depth of cavity and 10 inches (254 mm) high, with dovetail-shaped notches that prevent clogging with mortar droppings.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Building Products Inc.
2) Hohmann & Barnard, Inc.
3) Keene Building Products.
4) Mortar Net Solutions.
5) Wire-Bond.
6) York Manufacturing, Inc.

2. Rainscreen Drainage Mat for all stone veneer: Sheets or strips not less than full depth of cavity thick and installed to full height of cavity, to prevent weep holes from clogging with mortar.

a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1) Advanced Building Products Inc.
2) CavClear; a division of Archovations, Inc.
3) Keene Building Products.
4) Mortar Net Solutions.
5) Wire-Bond.

F. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
b. EaCo Chem, Inc.
c. PROSOCO, Inc.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. For reinforced masonry, use masonry cement mortar.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For reinforced masonry, use Type N. Verify with structural engineer.
2. For mortar parge coats, use Type N.
3. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
4. For interior nonload-bearing partitions, Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments do not exceed 5 percent of masonry cement by weight.
2. Mix to match Architect's sample.

E. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured in accordance with ASTM C143/C143M.

F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (13 mm) or minus 1/4 inch (6.4 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (13 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6.4 mm) in a story height or 1/2 inch (13 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), or 1/2-inch (13-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft. (3.2 mm in 3 m), 1/4 inch in 20 ft. (6.4 mm in 6 m), or 1/2-inch (13-mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), 3/8 inch in 20 ft. (10 mm in 6 m), or 1/2-inch (13-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft. (3.2 mm in 3 m), 1/4 inch in 20 ft. (6.4 mm in 6 m), or 1/2-inch (13-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), 3/8 inch in 20 ft. (10 mm in 6 m), or 1/2-inch (13-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), or 1/2-inch (13-mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3.2 mm), with a maximum thickness limited to 1/2 inch (13 mm).
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (10 mm) or minus 1/4 inch (6.4 mm).
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3.2 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond or bond pattern indicated on Drawings; do not use units with less-than-nominal 4-inch (102-mm) horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill cores in hollow CMUs with grout 24 inches (610 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay CMUs and hollow brick as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units and hollow brick with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods as follows:

1. Individual Metal Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. (0.25 sq. m) of wall area spaced not to exceed 24 inches (610 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (914 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

    a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
    b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Parge cavity face of backup wythe in a single coat approximately 3/8 inch (10 mm) thick. Trowel face of parge coat smooth.

D. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (305 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.

3.6 ANCHORED MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed connector sections and continuous wire in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 25 inches (635 mm) o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.7 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (152 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at corners by using prefabricated L-shaped units.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (914 mm) o.c. horizontally.

3.9 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:
1. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches (203 mm), and through inner wythe to within 1/2 inch (13 mm) of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches (51 mm) on interior face.
2. At lintels and shelf angles, extend flashing 6 inches (152 mm) minimum[, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches (152 mm) minimum, to edge of next full unit and turn ends up not less than 2 inches (51 mm) to form end dams.

3. Install metal drip edges and sealant stops with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use specified weep/cavity vent products to form weep holes.
2. Space weep holes 24 inches (610 mm) o.c. unless otherwise indicated.
3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Accessories" Article.

F. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.10 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3.2 mm per 305 mm). Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.11 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

3.12 MASONRY WASTE DISPOSAL

A. Excess Masonry Waste: Remove excess clean masonry waste and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 061050 - ROOF CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 through Division 26 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Framing with dimension lumber.
2. Wood blocking and nailers.
3. Plywood sheathing.
4. Isolation tape.

B. Related Sections
1. Section 072200 - Roof Insulation
2. Section 074113 – Metal Roof Panels
3. Section 076200 - Flashing and Sheet Metal

1.3 REFERENCES

A. American Lumber Standards Committee (ALSC): National Design Specification for Wood Construction.

B. American Wood Preservers' Association (AWPA): AWPA Book of Standards.

C. American Wood Preservers Bureau (AWPB): APA Design Construction Guide.

D. Product Standard of NBS (PS):
1. PS 1 - Construction and Industrial Plywood.
2. PS 20 - American Softwood Lumber Standard.

1.4 SUBMITTALS

A. Comply with provisions of Division 01.

B. Mark each product data cut-sheet by circling or highlighting and affix the corresponding Article and Paragraph designations from this Specification Section. Product data not so marked will be returned without review, for re-submittal complying with the above requirements.

C. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with

requirements. Indicate type of preservative used and net amount of preservative retained.

2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

D. Submit product data and certificates under provisions of the appropriate Division 1 Section for the following:
1. Dimensional treated lumber.
2. CDX plywood.

E. Submit product data for all wood fasteners, including their sizes, material, type and finish.

F. Laboratory Test Reports:
1. Provide documentation for adhesives and plywood, indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2. For each composite-wood product used, provide documentation indicating that the bonding agent contains no urea formaldehyde.
3. For each adhesive used, provide documentation indicating that the adhesive contains no urea formaldehyde.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in bulk as necessary to provide continuous operations and no Work slow-down. Schedule and coordinate with Owner to cause the least inconvenience to Owner's daily activities. All deliveries and unloading or loading activities are the responsibility of the Contractor. Owner will not take responsibility for any delivery activities.

B. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

C. Store materials in designated areas, out of the way of Owner’s on-going operations.

D. Store and handle materials to preclude damage and contamination with moisture or foreign matter.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber

graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19% at time of dressing unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry unless otherwise indicated, items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2.3 DIMENSION LUMBER FRAMING

A. Southern Pine;
1. Two-inch nominal dimension lumber: No. 1 common, stress rated Fb 1350.

2.4 PLYWOOD

A. DOC PS 1, Exposure 1, C-D Plugged, thickness as shown on drawings. Do not further treat after manufacture.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Provide fasteners in the sizes and of the type indicated.
1. Screws, Nails and Small Bolts in Treated Wood: Stainless steel.
2. Screws and Nails in Non-Treated Wood: Hot-dipped galvanized finish.

3. ¼-inch and Larger Diameter Bolts: Hot-dip galvanized finish.

C. Masonry Anchors:
1. Masonry and/or Concrete Substrate Fasteners: Steel pin and zinc-jacketed fasteners; Zamac “Hammer Screw,” ¼-inch x 1 1/2-inch, or approved equal.
2. Masonry Substrate Fasteners: “Tapcon,” or approved equal, in sizes and lengths dictated by existing conditions, and approved by the Architect.

2.6 MISCELLANEOUS MATERIALS

A. Isolation Tape: Multi-Purposed Grade Duct Tape, with polyethylene-coated cloth backing, natural rubber-based adhesive, and silver in color, equal to DT-11 as produced by 3-M Corporation.
1. Total Thickness: 11 mils, ASTM D3652.
2. Peel Adhesion: 88oz/in, ASTM D3330.
3. Tensile Strength: 464 oz/in, ASTM D3759.
4. Maximum Performance Temperature: 200° F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
1. Securely attach carpentry Work to substrate by anchoring and fastening as shown and as required by recognized standards.
2. Countersink nail heads on exposed carpentry Work and fill holes.
3. Use common wire nails, except as otherwise indicated.
4. Select fasteners of size that do not penetrate members where opposite sides are exposed to view or will receive finish materials.
5. Make tight connections between members.
6. Pre-drill holes when required to prevent splitting of wood.

B. Where wood-preservative-treated lumber is installed adjacent to metal decking, metal curbs or other steel members, install continuous isolation tape between wood and metal or steel components.

C. Discard units of material with defects which might impair quality of Work, and units which are too small to use in fabricating Work with minimum joints or optimum joint arrangement.

D. Provide wood products to size and shape shown and coordinate closely with all other scheduled Work for continuous operation of all trades.

E. Install wood nailers at perimeters and flanged penetrations, matching insulation in height.

F. When securing wood blocking by nailing:

1. Secure 3/4-inch and 1-inch materials with 8d stainless steel framing nails.
2. Secure 1-1/2 inch or 2-inch materials with 16d stainless steel framing nails.
3. Do not exceed nail spacing 12-inches on centers, or as detailed, and drive nails securely in place. Remove and dispose of bent or deformed nails or fasteners.

G. Bolts at Perimeter Nailers:
1. 5/8-inch diameter galvanized carriage bolts with washers, spaced at 36 inches on centers, with a minimum of 3 bolts per corner and one within 6 inches of each cut end of any lumber piece, corners and bends.
2. Draw bolt heads flush with top of nailers by hammering or drawing by tightening of the nut below the perimeter steel angle.

H. Plywood Decking over Metal Deck: Secure plywood through insulation or directly to steel decking with specified fasteners applied at the rate of thirty-three (33) fasteners per sheet. Fasteners shall be installed in a uniform pattern of alternating rows of seven (7) and six (6) fasteners per row laid parallel to the long edge of the sheet.

I. Correlate locations of nailers, blocking, and similar supports to allow proper attachment of other Work necessary.

J. Provide additional fasteners in existing perimeter wood blocking as necessary so fastener spacing does not exceed 24” on center staggered.

3.2 PROTECTION

A. Protective Walkways: Install full sheets of 1/2-inch plywood over minimum 1-inch insulation board over areas of new roof surface to be trafficked by personnel and wheeled vehicles.

3.3 CLEANING

A. Pick up spilled nails and fasteners from grounds and roof surface continually.

END OF SECTION 06 1050

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Single-component, Silyl-Terminated-Poly-Ether (STPe) fluid-applied, waterproofing and air barrier.
2. Joint and Seam Filler.
3. Joint Compound.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is approved by waterproofing manufacturer for installation of waterproofing required for this Project.

B. Mockups: Before beginning installation, install waterproofing to 100 sq. ft. of wall, sheathing to demonstrate surface preparation, crack and joint treatment, thick ness, texture, and execution quality.

1. If Architect determines mockups do not comply with requirements, reapply waterproofing and reinstall overlaying construction until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Pre-installation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and flashings, installation

1.5 WARRANTY

B. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Silyl-Terminated-Poly-Ether (STPe) fluid applied, Modified Polyurethane Waterproofing and air barrier:

1. Products: Subject to compliance with requirements, provide the following:

a. Prosoco: R-Guard, Cat-5.

2.2 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.

B. Joint and Seam Filler: Gun grade, single-component, fiber-reinforced, Sillyl Termi nated-Poly-Ether.

1. Prosoco: R-Guard Joint & Seam Filler.

C. Liquid Applied Flashing Membrane: Gun grade, single-component, fiber-reinforced, Sillyl-Terminated-Poly-Ether.

1. Prosoco: R-Guard, FastFlash.

D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recom mended by manufacturer for substrate and joint conditions.

1. Backer Rod: Closed-cell polyethylene foam.

F. Glass-faced Gypsum Wallboard: Minimum 1/2" thick glass-faced and reinforced gypsum core wall panels; Georgia-Pacific “DensGlass,” or an approved equal. Provide board in panel sizes up to maximum 48" x 96".

G. Gypsum Wallboard Fasteners: #8 x 1-1/4" long, or length as required, self-tapping galvanized or stainless steel drywall screws with flat Phillips head.

H. Gypsum Primer: Water-based primer for raw gypsum board edges.

1. Prosoco: R-Guard,Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated acrylic latex, polyurethane, or epoxy.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or over spray affecting other construction.

C. Replace damaged gypsum wall board. Install new wallboard directly over existing metal studs attaching with specified screws spaced at 8" on center maximum. Set boards with long side horizontal. Center vertical board edges over existing studs. Drive screws snugly to the board surface taking care not to rupture the facing but rather to provide a slightly concave indenture.

D. Apply gypsum board primer to raw board edges. Do not over apply. Allow primer to dry tack-free.

3.3 JOINT AND CRACK TREATMENT

A. Prepare, treat, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying before treating joints and coating surfaces.

1. Remove existing joint tape from all joints of existing sheathing.

2. Apply a thick bead of Joint & Seam Filler to all sheathing joints, seams and cracks.

3. Using a DRY joint knife, trowel or spatula, tool and spread the product. Spread 1-inch beyond seam at each side to 20-30 mil thickness.

4. Allow to skin before installing other waterproofing or air barrier components.

B. Install sheet flashing and bond to wall substrates where indicated or required according to waterproofing manufacturer's written instructions.

3.4 WATERPROOFING MEMBRANE APPLICATION

A. Roller apply to gypsum sheathing using vertical strokes with a slight diagonal slant. En sure there are no pinholes, voids or gaps in the membrane.

B. Seal masonry ties and other penetrations with joint compound per manufacturer’s recommendations as work progresses.

C. Apply to no less than recommended thickness of 12 mils. Proper thickness is reached when coating is opaque. If air or surface temperatures exceed 100° F, apply to shaded areas only or before daytime air and surface temperatures have reached their peak.

D. Allow waterproofing to dry and cure per manufacturer's recommendations prior to covering with masonry.

E. Inspect membrane before covering. Repair any punctures, translucent or damaged areas by applying additional waterproofing membrane. Overlap repairs, transitions, and other barrier components to ensure positive drainage and continuity of the air and water resistive barrier.

3.5 CURING, PROTECTION, AND CLEANING

A. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Clean spillage and soiling from adjacent construction using cleaning

END OF SECTION 071416

SECTION 072200 - ROOF INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 through Division 26 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Polyisocyanurate board insulation.
2. Roof cover board.
3. Base sheet and fasteners.
4. Insulation fasteners.
5. Insulation adhesive.
6. Fiber cant strips.

B. Related Sections
1. Section 061050 - Roof Carpentry
2. Section 074113 - Symmetrical Metal Roof Panels
3. Section 074140 - Metal Wall Panels
4. Section 075216 - Modified Bitumen Roof System
5. Section 075220 - Roofing Installer's Warranty
6. Section 076200 - Flashing and Sheet Metal

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Provide installed insulation and/or base sheet that withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roof System Design: Provide a roofing system that meets or exceeds the wind uplift pressures indicated on the drawings or, if not indicated, in accordance with applicable versions of ASCE 7, FM 1-28 AND FM 1-29.

D. Approval Standards: Meet testing standards of FM 4450 and FM 4470.

1.4 SUBMITTALS

A. Comply with provisions of Division 01.
B. Mark each product data cut-sheet by circling or highlighting and affix the corresponding Article and Paragraph designations from this Specification Section. Product data not so

marked will be returned without review, for re-submittal complying with the above requirements.

C. Product Data: For each type of product indicated with construction details, material descriptions, dimensions of individual components and profiles, and accessories, including but not limited to the following:
1. Polyisocyanurate insulation board.
2. Crickets and saddles.
3. Roof cover board.
4. Cants.
5. Asphalt primer.
6. Fasteners for roof decks.
7. Insulation adhesive.
8. Fiberglass base sheet.
9. Base sheet fasteners.

D. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work, and as follows:
1. Tapered insulation, including slopes and transitions at roof drains and scuppers, where applicable.
2. Crickets, saddles, and tapered edge strips, including slopes.
3. Wind zone roof plan for the actual project, if not provided in the Contract Documents, depicting field (interior/exterior), perimeter and corner zones in compliance with ASCE 7-10 and IBC 2015.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof (interior/exterior) wind zone locations meeting FM Class 135 along with documented evidence that patterns meet wind uplift criteria from AHJ adopted versions of IBC, ASCE 7, FM 1-28 and FM 1-29.

E. Submit specified manufacturer’s letters and certificates under Section 07 5216.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
1. Inspect for damage.
2. Store products in weather protected environment, clear of ground and moisture.
3. Deliver materials in quantities to allow continuity of application throughout the Project.
4. Coordinate shipment receipt as necessary to cause Owner least amount of interference in Owner’s operations. Owner will not take responsibility for product deliveries.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store materials subject to water damage in fully enclosed, watertight storage trailers.
2. Do not store insulation materials on the roof overnight.
3. Store materials on the roof surfaces only on the morning they will be installed. Do not store more materials on roof overnight unless approved by the Architect.
4. Maximum Allowable Loading on Roof: 20 pounds per square foot.

D. Handle materials in a manner precluding damage and contamination by moisture or other harmful/foreign matter.

E. Promptly mark, remove from the site, and discard any materials contaminated by moisture.

1.6 PROJECT CONDITIONS

A. Do not apply any portion of the roof system or its accessories during precipitation, or start application in the event precipitation is threatening, unless proper precautions have been taken.

B. Do not apply insulation during inclement weather. Temperatures must be a minimum of 40° Fahrenheit and rising. Do not apply insulation material to damp or frozen deck or substrate.

C. Do not apply insulation when the wind is determined to be detrimental to safe installation practices.

1.7 WARRANTY

A. The manufacturer of the insulation shall be approved in writing by the manufacturer of the roof membrane system. Submit manufacturer’s letter.

B. Include insulation as part of 20-year NDL warranty required for the overall roofing system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

B. Polyisocyanurate Insulation Board:
1. Rigid flat and tapered polyisocyanurate foam insulation board, meeting ASTM C-1289, Type II, Class 1 or Class 2, Grade 2 with organic or in-organic insulation board facers.
2. Sizes:
   a. 48 inches x 96 inches maximum where mechanically fastened.
   b. 48 inches x 48 inches maximum where adhesively applied.
3. Board thickness: As shown on the Drawings. Minimum base layer thickness shall

be 2 inches.
4. Tapered insulation slope: As shown on the Drawings.
5. R-value (In-service): Minimum R-25.

C. Crickets: Provide factory tapered polyisocyanurate insulation boards with the same characteristics as Article 2.1.B above.
1. Minimum 1/2-inch per foot slope. Widths of crickets and saddles shall not be less than 1/3 their lengths, unless otherwise shown on Drawings.

D. Roof Cover Board:
1. Acceptable Materials:
a. “DensDeck Prime,” by Georgia-Pacific.
b. “Dexcell FA” by National Gypsum Company.
c. “Securock,” by U.S. Gypsum.
2. Thickness:
a. Over Field of Roof Insulation: 1/2-inch thickness.
b. Over Cants, Roof Curbs & Vertical Surfaces: 1/4-inch thickness.
3. Board Size:
a. 48-inches x 96-inches where mechanically fastened.
b. 48-inches x 48-inches where adhesively applied.
4. Miter edges of ¼-inch roof board strips at tops and bottoms of cants.

E. Cant Strips:
1. Fire-retardant wood fiber or perlite, meeting ASTM C-728.
2. Size: 1.5 inches thick minimum x 4 inches face minimum.

2.2 RELATED MATERIALS

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing

B. Asphalt Primer: Asphalt cut-back type primer manufactured in accordance with ASTM D-41 standards and without asbestos, for use on masonry, metal and other surfaces.

C. Fasteners for Metal Decks: Coated steel insulation screws, using metal disks, and of sufficient length for proper penetration of roof deck.

D. Insulation Adhesive: For use in adhering fiber cant strips and gypsum cover board at curbs and other vertical flashing surfaces:
1. Olybond 500 or as recommended by roofing membrane manufacturer.
2. Note that Duotack 365 is not acceptable.

2.3 BASE SHEET MATERIALS

A. Fiberglass Base Sheet: Asphalt-impregnated fiberglass mat, produced by the roofing membrane manufacturer, and meeting requirements of ASTM D-4601, Type II.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG Approvals 4470; designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
1. Mechanical Fasteners for Base Sheet:

a. Concrete Deck: Coated nail and plate: ES-90 by ES Products or approved equal.
b. Secondary Disks for Fasteners: Sized to meet requirements to resist wind uplift pressures specified in Part 1 “Performance Requirements” of this Section.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Verify that surfaces and site conditions are ready to receive work and that deck is supported and secured.

B. Verify the deck is clean and smooth, free of depressions, waves, or projections, properly sloped to drains or eaves.

C. Verify that deck surfaces are dry and free of snow or ice. Verify flutes of metal deck are clean and dry. Confirm deck dryness by moisture meter; maximum allowable: 12-percent.

D. Verify that roof openings, curbs, pipes, sleeves, ducts, and vents through the roof are solidly set and wood nailing strips are in place.

E. Beginning of installation means installer accepts existing surfaces.

3.2 BASE SHEET INSTALLATION

A. Fiberglass base sheet shall be mechanically fastened in accordance with ASCE 7 and FM Class 135.

B. The minimum fastening patterns for wind zones shall be as follows:
1. Field: 9” o.c. in the min. 3-inch lap and four equally spaced rows between laps at 9” o.c. staggered.
2. Perimeter: 6” o.c. in the min. 3-inch lap and four equally spaced rows between laps at 6” o.c. staggered.
3. Corner: 4” o.c. in the min. 3-inch lap and four equally spaced rows between laps at 4” o.c. staggered.

3.3 INSULATION BOARD INSTALLATION

A. Base Layer Application at Metal Decks: Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows and with long joints continuous at right angles to the flutes.
1. Locate end joints over crests of decking.
2. Trim insulation neatly to fit around penetrations and projections, and to fit intersecting sloping roof decks.
3. Maximum joint width between adjacent boards shall be not more than 1/4-inch. Fill larger gaps with insulation.
4. Cut and fit insulation within 1/4-inch of nailers, projections and penetrations.
5. Do not install more board stock than can be covered during each day’s operation.
6. Screws shall be of sufficient length to penetrate the existing or new metal deck by approximately 1 inch. Extra-long screws are not permitted.
7. Mechanical fastening shall be in accordance with ASCE 7 and FM Class 135

requirements and approved shop drawings.

8. Base layer thickness shall not exceed 2.5 inches.

B. Upper Layer Application: Install upper layers of insulation and cover board with longitudinal and transverse joints of each layer offset not less than 12 inches from previous layer.
   1. Adhere each upper layer of insulation and cover board using adhesive.
   2. Place, fit and trim upper layers of insulation as required for base layer.
   3. Set each layer of insulation in ribbons of bead-applied insulation adhesive or full-spread adhesive, firmly pressing and maintaining insulation in place.
   4. Space adhesive ribbons to achieve wind uplift pressures shown on the drawings and in accordance with ASCE 7 and FM Class 135 requirements and approved shop drawings.

C. Base Sheet Application at Lightweight Concrete Decks: Install one ply of the specified fiberglass base sheet, attaching with specified base ply fasteners with disks. Attach the base sheet to meet the spacing pattern requirements of ASCE 7 and FM Class 135.

D. Modified Bitumen Base Ply Application at Structural Concrete Decks: Torch apply per the requirements of Section 07 5216 – Modified Bitumen Roof System.

E. Insulation Application at Cementitious and Plywood Decks:
   1. Install insulation layers over mechanically fastened base sheet except structural concrete.
   2. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows and with long joints continuous at right angles to the flutes.
      a. Base layer thickness shall not exceed 2.5 inches.
   3. Butt boards tightly together. Walk-in boards to ensure solid adhesion. Fill gaps. Stagger joints between adjacent boards.
   4. Do not install more board stock than can be covered during each day's operation.
   5. Set each layer of insulation in ribbons of bead-applied insulation adhesive or full-spread adhesive, firmly pressing and maintaining insulation in place.
   6. Space adhesive ribbons to achieve wind uplift pressures shown on the drawings and in accordance with ASCE 7 and FM Class 135 requirements and approved shop drawings.
   7. Lay insulation board in full sheets wherever possible, and carefully fit and push against adjoining boards, nailers and/or other stops to form a tight joint.
   8. Miter edges of insulation boards at ridges, or elsewhere, to prevent open or irregular joints. Fill joints with tightly-fit, cut pieces of matching roof insulation.
   9. Install upper layers of insulation and cover board with longitudinal and transverse joints of each layer offset not less than 12 inches from previous layer.

F. Cricket Installation:
   1. Apply solidly in full embedment of low-rise foam adhesive.
   2. Slope materials a minimum of twice the slope of the aggregate roof slope over which crickets and saddles are installed.
   3. Extend cricket widths not less than 1/3 their lengths, unless otherwise detailed.

G. Cant Strip Installation: Solidly adhere strips in full embedment of low-rise foam adhesive at all vertical terminations and as detailed.

H. Insulation Application at Exterior Walls:

1. Install board insulation on masonry or metal panel walls behind new wall panels in as shown on the drawings.
2. Protect edges at door and window openings or other penetrations as tested in accordance with NFPA 285.
3. Butt edges and ends tightly to adjacent boards and protrusions.
4. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.4 COVER BOARD INSTALLATION

A. Installation shall comply with roof insulation guidelines stipulated above.

B. Over Field of Insulation: Fully adhere 1/2-inch thick roof cover board and comply with ASCE 7 and FM requirements stipulated for roof insulation.

C. Miter cover board edges where ridges are formed at tops and bottoms of crickets, to prevent open or irregular joints.

D. Cover cants, roof curbs and vertical surfaces where indicated with 1/4-inch roof cover board.
1. Mechanically fasten to wood blocking with galvanized ring shank cap nails.
2. Set in full embedment of low-rise foam adhesive at non-nailable substrates.

E. Leave surfaces clean in preparation for roof membrane installation.

3.5 PROTECTION

A. Protect installed insulation and cover board from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072200

SECTION 075220 - ROOFING INSTALLER'S WARRANTY

WHEREAS_____,

of_____,

Herein called the "Contractor," has performed roofing and associated Work on the following project:

Project Name: HJISD - SOUR LAKE ELEMENTARY KITCHEN ADDITION

Acceptance Date: _____ Warranty Period: Two (2) Years

Date of Expiration: _____

AND WHEREAS the Contractor has contracted with Owner to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period.

NOW THEREFORE the Contractor hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period will at its own cost and expense, make or cause to be made such repairs to, or replacement of said Work as is necessary to correct faulty and defective Work, and as is necessary to maintain said Work in watertight condition.

This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by: (a) lightning, windstorms, and other unusual phenomena of the elements; (b) fire; (c) failure of roofing system substrate including cracking, settlement, excessive deflection, deterioration, and decomposition; (d) faulty construction of vents, mechanical equipment, and other penetrations not installed as part of the Work; (e) repeated vapor condensation on bottom of roofing; and (f) activity on roofing by other persons including construction contractors and maintenance personnel, whether authorized or unauthorized by Owner.

2. When Work has been damaged by any of the foregoing causes, Warranty shall be null and void until such damage has been repaired by the Contractor, and until cost and expense thereof has been paid for by the Owner, or by another responsible party so designated.

3. The Contractor is responsible for Work covered by this Warranty, but is not liable for consequential damages to buildings or building contents resulting from leaks or faults or defects of the Work.

4. During Warranty Period, if the Owner allows alterations of Work by anyone other than the Contractor, including cutting, patching and maintenance in connection with penetrations, attachment of other Work, and positioning of anything on roof, this Warranty shall become null and void upon date of said alterations, but only to extent said alterations affect Work covered by this Warranty. If the Owner engages the Contractor to perform said alterations, Warranty shall not become null and void, unless the Contractor, before starting said Work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void upon date of said change, but only to extent said changes affect Work covered by this Warranty.

6. Owner shall promptly notify the Contractor of observed, known, or suspected leaks, defects or deterioration, and shall afford reasonable opportunity for the Contractor to inspect the Work, and to examine evidence of such leaks, defects or deterioration.

7. This Warranty is recognized to be the only Warranty of the Contractor on said Work, and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve the Contractor of responsibility for performance of original Work.

IN WITNESS THEREOF, this instrument has been duly executed this day of , 202 .

_____
Contractor Name and Address

_____ _____
Typed name and Title Signature

_____ _____
Telephone Number Fax Number

Notary Seal

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) MEMBRANE ROOFING - CARLISLE

PART 1 GENERAL

2.01 SECTION INCLUDES

A. Mechanically attached thermoplastic polyolefin (TPO) roofing membrane.

B. Adhered system with thermoplastic polyolefin (TPO) roofing membrane.

C. Insulation, flat and tapered.

D. Vapor retarder.

E. Deck sheathing.

F. Roofing cant strips, stack boots, roofing expansion joints, and walkway pads.

2.02 RELATED REQUIREMENTS

A. Section 07 6200 - Sheet Metal Flashing and Trim: Counterflashings, reglets etc.

2.03 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2023a.

C. ASTM D41/D41M - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing; 2011 (Reapproved 2023).

D. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method; 1983 (Reapproved 2018).

E. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing; 2021.

F. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2011 (Reapproved 2019).

G. FM (AG) - FM Approval Guide; Current Edition.

H. FM DS 1-28 - Wind Design; 2015, with Editorial Revision (2024).

I. FM DS 1-29 - Roof Deck Securement and Above-Deck Roof Components; 2016, with Editorial Revision (2022).

J. NRCA (RM) - The NRCA Roofing Manual; 2024.

2.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.
   1. Review preparation and installation procedures and coordinating and scheduling required with related work.

2.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's written information listed below.
   1. Product data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements.

C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

G. Warranty:
   1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
   2. Submit installer's certification that installation complies with all warranty conditions for the waterproof membrane.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

2.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum twenty (20) years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section:
   1. With minimum five (5) years documented experience.
   2. Approved by membrane manufacturer.

2.07 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 7419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.

C. Protect products in weather protected environment, clear of ground and moisture.

D. Protect foam insulation from direct exposure to sunlight.

E. Provide Safety Data Sheets (SDS) at the project site at all times during transportation, storage, and installation of materials.

F. Comply with requirements from Owner to prevent overloading or disturbance of the structure when loading materials onto the roof.

2.08 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather. Refer to manufacturer's written instructions.

B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above ____ degrees F.

C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

E. Proceed with work so new roofing materials are not subject to construction traffic as work progresses.

F. Do not allow grease, oil, fats, or other contaminants to come into direct contact with membrane.

2.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within 10 years after installation.

C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.

1. Warranty Term: 20 years.
2. For repair and replacement include costs of both material and labor in warranty.
3. Include accidental punctures according to the manufacturer's standard warranty terms.
4. Include hail damage according to the manufacturer's standard warranty terms.

PART 2 PRODUCTS

3.01 MANUFACTURER

A. Carlisle SynTec Systems.

B. Firestone Building Products.

C. GAF.

D. GenFlex Roofing Systems.

E. Johns Manville; a Berkshire Hathaway company.

F. Mule-Hide Products Co., Inc.

G. Versico Roofing Systems.

3.02 ROOFING APPLICATIONS

A. TPO Membrane Roofing: One ply membrane, asphalt adhered, over insulation.

B. Roofing Assembly Performance Requirements and Design Criteria:
1. Solar Reflectance Index (SRI): Minimum of 64 based on three-year aged value; if three-year aged data is not available, minimum of 82 initial value.
   a. Calculate SRI in accordance with ASTM E1980.
   b. Field applied coating may not be used to achieve specified SRI.
2. Wind Uplift:
   a. Designed to withstand wind uplift forces calculated with ASCE 7.
   b. Design Wind Speed: In accordance with local building code and authorities having jurisdiction (AHJ).
3. Insulation Thermal Resistance (R-Value): Provide R-Value over entire roof deck in accordance with local building code requirements.
4. Drainage: No standing water within 48 hours after precipitation.

3.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

A. Base Sheet: Manufacturer's standard, non-asphaltic, resin-bound, fiberglass-reinforced mat with mineral-filled, fire-resistant coating on one side.

B. Membrane:
1. Material: Thermoplastic Polyolefin (TPO) complying with ASTM D6878/D6878M.
2. Reinforcing: Internal fabric.
3. Thickness: 60 mil (0.060 inch), minimum.
4. Sheet Width: Factory fabricated into largest sheets possible.
5. Color: White.

C. Seaming Materials: As recommended by membrane manufacturer.

D. Membrane Fasteners: As recommended and approved by membrane manufacturer.

E. Vapor Retarder: Material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials.
1. Fire-retardant adhesive.

F. Flexible Flashing Material: Same material as membrane.

G. Base Flashing: Provide waterproof, fully adhered base flashing system at all penetrations, plane transitions, and terminations.

3.04 DECK SHEATHING AND COVER BOARDS

A. Cover Board: Polyisocyanurate (ISO) thermal board, complying with ASTM C1289; Type II - Faced with coated-glass facer on both major surfaces of core foam, Class 4 with thickness of 1/2 inch, and Grade 1 with 109 psi, maximum, compressive strength.

3.05 INSULATION

A. Composite Polyisocyanurate (ISO) Board Insulation: Composite insulation panel comprised of 1/2 inch thick high-density ISO cover board laminated to ISO base insulation, complying with ASTM C1289.
   1. Base Insulation: Type II, Class 2, Grade 2, with 20 psi, minimum, compressive strength.
   2. Cover Board: Type II, Class 4, Grade 1, with 109 psi, maximum, compressive strength, 1/2 inch thick.
   3. Overall Board Thickness: as required to achieve R-25 total for roof system (existing roof system assumed to be R-9).

3.06 ACCESSORIES

A. Prefabricated Flashing Accessories:
   1. Corners and Seams: Same material as membrane, in manufacturer's standard thicknesses.
   2. Penetrations: Same material as membrane, with manufacturer's standard cut-outs, rigid inserts, clamping rings, and flanges.
   3. Sealant Pockets: Same material as membrane, with manufacturer's standard accessories, in manufacturer's standard configuration.
   4. Pressure Sensitive Cover Strips: 6 inches wide, 45 mil, 0.045 inch thick, non-reinforced TPO membrane laminated to 35 mil, 0.035 inch thick cured synthetic rubber with pressure sensitive adhesive.
   5. Miscellaneous Flashing: Non-reinforced TPO membrane; 80 mil, 0.080 inch thick, in manufacturer's standard lengths and widths.

B. Asphalt Primer: ASTM D41/D41M primer for concrete decks, existing smooth built-up roofing, mineral surfaced cap sheet, or modified bitumen membranes.

C. Insulation Adhesive: Two-component polyurethane, expanding foam.
   1. Products:

D. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self adhering.

E. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
   1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.

F. Membrane Adhesive: As recommended by membrane manufacturer.
   1. Product:

G. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.

H. Sealants: As recommended by membrane manufacturer.
   1. Product:

I. Cleaner: Manufacturer's standard, clear, solvent-based cleaner.

J. Edgings and Terminations: Manufacturer's standard edge and termination accessories.

PART 3 EXECUTION

6.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

6.02 PREPARATION, GENERAL

A. Clean substrate thoroughly prior to roof application.

B. Do not begin work until other work that requires foot or equipment traffic on roof is complete.

C. Apply manufacturer's recommended vapor retarder or temporary roof before roof installation.

6.03 CONCRETE DECK PREPARATION

A. Verify adjacent precast concrete roof members do not vary more than 1/4 inch in height. Verify grout keys are filled flush.

B. Fill surface honeycomb and variations with latex filler.

C. Confirm dry deck by moisture meter with 12 percent moisture maximum when tested per ASTM D4263.

D. Adhered to Deck with Asphalt: Prime concrete deck with ASTM D41/D41M primer. Allow primer to dry completely before applying hot asphalt.

6.04 INSTALLATION - GENERAL

A. Perform work in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.

B. Do not apply roofing membrane during unsuitable weather.

C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

6.05 INSULATION APPLICATION

A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
   1. Extend vapor retarder under cant strips and blocking to deck edge.
   2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

B. Attachment of Insulation:
   1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.
   2. Embed second layer of insulation into full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.

C. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.

D. Lay boards with edges in moderate contact without forcing, and gap between boards no greater than 1/4 inch. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.

E. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.

F. Do not apply more insulation than can be completely waterproofed in the same day.

6.06 MEMBRANE APPLICATION

A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

B. Shingle joints on sloped substrate in direction of drainage.

C. Asphalt Adhered Application: Apply asphalt at manufacturer's recommended rate. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

D. Seam Welding:
1. Seam Welding: Overlap edges and ends and seal seams by heat welding, minimum 2 inches.
2. Cover seams with manufacturer's recommended joint covers.
3. Probe seams once welds have thoroughly cooled, in approximately 30 minutes.
4. Repair deficient seams within the same day.
5. Seal cut edges of reinforced membrane after seam probe is complete.

E. Mechanical Attachment:
1. Apply membrane and mechanical attachment devices in accordance with manufacturer's instructions.

F. At intersections with vertical surfaces:
1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
2. Fully adhere flexible flashing over membrane and up to nailing strips.

G. Coordinate installation of roof drains and sumps and related flashings. Locate all field splices away from low areas and roof drains. Lap upslope sheet over downslope sheet.

H. Install walkway pads at areas of concentrated traffic and as shown on Drawings. Space pad joints to permit drainage.

I. Daily Seal: Install daily seal per manufacturers instructions at the end of each work day. Prevent infiltration of water at incomplete flashings, terminations, and at unfinished membrane edges.

6.07 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 07 5423

SECTION 075600 - FLUID APPLIED MEMBRANE FLASHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 through Division 26 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Fluid applied membrane flashing.
2. Preparation of substrate to receive flashing materials.

B. Related Sections:
1. Section 075423 – Thermoplastic Polyolefin (TPO) Membrane Roofing
2. Section 075220 - Roofing Installer’s Warranty
3. Section 076200 - Flashing and Sheet Metal

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" for definition of terms related to roofing work in this Section.

1.4 REFERENCES

A. References in these specifications to standards, test methods and codes, are implied to mean the latest edition of each such standard adopted. The following is an abbreviated list of associations, institutions and societies which may be used as references throughout these specifications:
1. ACI American Concrete Institute, Hills, MI
2. ASTM American Society for Testing and Materials, Philadelphia, PA
3. FM Factory Mutual Engineering and Research, Norwood, MA
4. NRCA National Roofing Contractors Association, Rosemont, IL
5. OSHA Occupational Safety and Health Administration, Washington, DC
6. UL Underwriters Laboratories, Northbrook, IL

1.5 SUBMITTALS

A. Comply with provisions of Division 01.

B. Mark each product data cut-sheet by circling or highlighting and affix the corresponding Article and Paragraph designations from this Specification Section. Product data not so marked will be returned without review, for re-submittal complying with the above requirements.

C. For each type of product indicated with construction details, material descriptions,

dimensions of individual components and profiles, and accessories, including but not limited to the following:

1. Catalyst.
2. Resin.
3. Membrane and flashing reinforcement.
4. Elastomeric sealant.
5. Cleaner/solvent.
6. Preparation paste.
7. Repair tape.

D. Products shall be listed as part of the warrantied roof system in the Manufacturer's Certification submitted under Section 075216.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products and systems specified in this Section with minimum five years documented experience, including a minimum of three (3) projects of comparable size, using specified system, installed in the State of Texas within that five-year period. Manufacturer shall certify, in writing, materials to be used in the roof assembly as being compatible with their system, whether manufactured by that company or by others.

B. Source Limitations: Obtain components for roofing system from or approved by roofing system manufacturer

C. Perform Work in accordance with NRCA Manual of Roof Maintenance and Roof Repair, NRCA Roofing and Waterproofing Manual, and manufacturer's instructions.

D. Workers: Comply with requirements specified for the modified bitumen roof membrane section.

E. Do not allow materials which have not been approved through the submittal process to be brought onto the project site.

1. Materials brought onto the site which have not been approved through the submittal process will be rejected and shall be removed immediately.
2. Remove any materials incorporated into the Work, which have not been approved through the submittal process.

F. Manufacturer Requirements: The flashing system manufacturer shall provide direct trained company personnel to attend necessary job meetings, perform periodic inspections as necessary and conduct a final inspection upon successful completion of the project.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable local codes for roof assembly fire hazard requirements and application procedures.

B. Fire Hazard Classification: UL Class A.

C. Roof Assembly Classification: FM Class 1-130 construction, in accordance with FM

Construction Bulletin 1-28.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original sealed and labeled shrouds on pallets and labeled with manufacturer's name, product brand name and type.
   1. Inspect for damage.
   2. Replace damaged or deteriorated materials.
   3. Deliver materials in quantities to allow continuity of application throughout the Project.
   4. Coordinate shipment receipt as necessary to cause Owner least amount of interference in Owner’s operations. Owner will not take responsibility for product deliveries.

B. Store roofing materials in weather protected environment, clear of ground and moisture and protected from direct sunlight.
   1. Stand and store roll materials on end.
   2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
   3. Protect roof insulation materials from physical damage. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

C. Handle and place roofing materials and equipment in a manner to avoid permanent deflection of deck.
   1. Do not store materials on roof overnight.
   2. Maximum Allowable Loading on Roof: 20 pounds per square foot.
   3. Promptly mark, remove from the site and legally dispose of:
      a. Damaged materials,
      b. Materials contaminated by moisture and other sources,
      c. Liquid materials that cannot be applied within its stated shelf life.

1.9 PROJECT CONDITIONS

A. Requirements Prior to Job Start:
   1. Notification: Give a minimum of 5-days’ notice to the Owner and manufacturer prior to commencing any Work and notify both parties on a daily basis of any change in Work schedule.
   2. Permits: Obtain permits required by local agencies and pay fees which may be required for the performance of the Work.
   3. Safety: Familiarize every member of the application crew with fire and safety regulations recommended by OSHA, NIOSH, NRCA and other industry or local governmental groups.
      a. Workers shall wear a long sleeve shirt with long pants and Work boots.
      b. Workers shall use only butyl rubber or nitrile gloves when mixing or applying fluid flashing products.
      c. Safety glasses with side shields are required for eye protection.
      d. Use local exhaust ventilation to maintain Worker exposure below the published Threshold Limit Value (TLV).
      e. If the airborne concentration poses a health hazard, becomes irritating or

exceeds recommended limits, use a NIOSH approved respirator in accordance with OSHA Respirator Protection requirements published under 29 CFR 1910.134. The specific type of respirator will depend on the airborne concentration.

f. A filtering face piece or dust mask is not acceptable for use with this product if TLV filtering levels have been exceeded.

B. Environmental Requirements:

1. Precipitation: Do not apply fluid flashing materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials and building interiors are protected from possible moisture damage or contamination.
2. Temperature Restrictions – Primer Resins: Do not apply primer resin if there is a threat of inclement weather. Apply the primer resin while air temperature is between 32°F (0°C) and 104°F (40°C), and while the substrate temperature is between 32°F (0°C) and 122°F (50°C). Do not apply resin materials when ambient or substrate temperatures exceed that indicted above.
3. Temperature Restrictions – Summer Grade Roofing Resins: Do not apply roofing resins if there is a threat of inclement weather. Apply membrane resin while air temperature is between 59°F (15°C) and 104°F (40°C), providing the substrate temperature is between 50°F (10°C) and 122°F (50°C). Do not apply materials when ambient or substrate temperatures exceed that indicted above.

C. Protection Requirements:

1. Membrane and Property Protection: Provide protection against staining and mechanical damage for newly applied roofing and adjacent building surfaces.

1.10 WARRANTY

A. Work of this Section shall be included in the two-year written warranty against defects in materials and Workmanship, beginning on the date of Substantial Completion of the overall Project, as executed on the form found in Section 075220.

B. New Roof System: Fluid Applied Flashing to be included in roof membrane manufacturer's 20-Year NDL Warranty.

PART 2 - PRODUCTS

2.1 MEMBRANE / FLASHING SYSTEM

A. Catalyst: A reactive agent used to induce curing of polymethylmethacrylate (PMMA) resins.

1.	Derbigum	Derbiflash RS Catalyst.
2.	Johns Manville	Seamfree™ PMMA Catalyst.
3.	Siplast	"Pro Catalyst".
4.	Soprema	ALSAN RS Catalyst Powder.
5.	U.S. Ply, Inc.	Manufacturer's approved PMMA product.

B. Resin for Membrane and Flashing Applications: A

flexible, PMMA-based resin for use in combination with a polyester fabric to form a monolithic, reinforced roofing or flashing membrane.

1. Derbigum — Derbitite RS 230 Flash.
2. Johns Manville — Seamfree™ PMMA Flashing Resin.
3. Siplast — “Parapro Roof Resin”.
4. Soprema — ALSAN RS 230 Flash.
5. U.S. Ply, Inc. — Manufacturer’s approved PMMA product.

C. Membrane and Flashing Reinforcement: A polyester fabric reinforcement as supplied by the membrane system manufacturer.

1. Derbigum — Derbiflash Fleece.
2. Johns Manville — Seamfree™ PMMA Scrim.
3. Siplast — “Pro Fleece”.
4. Soprema — ALSAN Polyfleece.
5. U.S. Ply, Inc. — Manufacturer’s approved PMMA product.

2.2 AUXILIARY MATERIALS

A. Elastomeric Sealant: A moisture-curing, non-slump elastomeric sealant designed for roofing applications. The sealant shall be approved by the roof membrane manufacturer for use in conjunction with the roof membrane materials.

B. Cleaner/Solvent: A clear solvent used to prepare metal and plastic surfaces prior to application of the catalyzed resin flashing membranes and to reactivate transition areas of in-place resin flashing membranes at tie-ins and between staged coats of resin.

C. Preparation Paste: A multi-component, fast curing, PMMA-based paste used for remediation of depressions in substrate surfaces or other irregularities.

1. Derbigum — Derbiflash RS Paste.
2. Johns Manville — Seamfree™ PMMA Joint/Repair Paste.
3. Siplast — “Pro Paste Resin”.
4. Soprema — ALSAN RS Paste.
5. U.S. Ply, Inc. — Manufacturer’s approved product.

D. Repair Tape: A white, flexible, coated cotton cloth tape designed for treatment of insulation panel joints and deck/wall transitions.

1. Derbigum — Manufacturer’s approved product.
2. Johns Manville — JM Coating Repair Tape.
3. Siplast — “Pro Tape”.
4. Soprema — SOPRANATURE™ Seam Tape.
5. U.S. Ply, Inc. — Manufacturer’s approved product.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Contractor shall examine the Contract Documents and conditions which affect the quality of his Work. Deviations or unsatisfactory conditions shall be reported to the Owner's Representative in writing. No Work shall proceed until conditions are satisfactory

to meet requirements of the Contract Documents.

B. Conduct a pre-roofing conference with the manufacturer's technical representative, applicator and architect prior to ordering materials and starting Work.
   1. Discuss the products and application techniques.
   2. Written minutes shall be maintained and submitted by the Contractor to the Architect and Owner.
   3. The Work and products may be adjusted depending on recommendations of the manufacturer's technical representative.

3.2 SUBSTRATE PREPARATION

A. Preparation of roof penetrations to receive new membrane flashing: Grind and scrape away loose dirt, rust, membrane and any other deleterious materials from the surfaces of the piping, conduit or other material scheduled to receive the new coating.

B. Wipe down affected surfaces with specified cleaner/solvent as recommended by the manufacturer.

C. Ply Sheet Application: Bond the modified bitumen ply sheet by adhesive application to the prepared substrate, utilizing minimum 3-inch side and end laps. Cut a dog ear angle at the end laps on overlapping selvage edges. Using a clean trowel, apply pressure to top seal T-laps immediately following sheet application. Stagger end laps a minimum of 3 feet. Follow manufacturer's specifications regarding maximum exposure periods prior to application of the liquid-applied finish membrane.

3.3 MIXING OF RESIN PRODUCTS

A. Preparation/Mixing/Catalyzing Resin Products: Pour the desired quantity of resin into a clean container and using a spiral mixer or mixing paddle, stir the liquid for the time period specified by the resin manufacturer.

B. Calculate the amount of catalyst powder needed using the manufacturer's guidelines and add the pre-measured catalyst to the primer. Mix again for the time period specified by the resin manufacturer, ensuring that the product is free from swirls and bubbles. It is imperative that air is not entrained into the product during the mixing process. To avoid aeration, do not use a spiral mixer unless the spiral section of the mixer can be fully contained in the liquid during the mixing process.

C. Mix only enough product to ensure that it can be applied before expiration of resin pot life.

3.4 FLASHING AND FIELD MEMBRANE APPLICATION

A. Using masking tape, mask the perimeter of the area to receive the flashing system. Apply resin primer to substrates requiring additional preparation and allow primer to set.

B. Pre-cut reinforcing fabric to ensure a proper fit at transitions and corners prior to membrane application.

C. Apply an even, generous base coat of flashing resin using a roller at the manufacturer's recommended rate to prepared surfaces requiring flashing coverage.

1. Work the reinforcing fabric into the wet, resin using a brush or roller to fully embed the reinforcing fabric in the resin and remove trapped air.

2. Lap reinforcing fabric layers a minimum of 2 inch (5 cm) and apply an additional coat of resin between layers of overlapping fleece.
3. Again, using a roller, apply an even top coat of resin immediately following embedment of the reinforcing fabric, ensuring full saturation of the reinforcing fabric.
4. Ensure that the flashing resin is applied to extend a 0.25 inch (6 mm) beyond the reinforcing fabric. Remove the tape before the resin sets.
5. Make allowances for saturation of roller covers and application equipment.

D. Should Work be interrupted for more than 12 hours or the surface of the resin becomes dirty or contaminated by the elements, wipe the surface to be lapped with new flashing resin using the specified cleaner/solvent. Allow the surface to dry for a minimum 20 minutes and a maximum 60 minutes before continuing Work.

3.5 FIELD QUALITY CONTROL AND INSPECTIONS

A. Site Condition: Leave areas around job site free of debris, roofing materials, equipment and related items after completion of job.

B. Notification of Completion: Notify the manufacturer by means of manufacturer's printed Notification of Completion form of job completion in order to schedule a final inspection date.

C. Post-Installation Meeting: Hold a meeting at the completion of the project, attended by parties that were present at the pre-job conference. A punch list of items required for completion shall be compiled by the Contractor and the manufacturer's representative. Complete, sign, and mail the punch list form to the manufacturer's headquarters.

D. Issuance of The Guarantee: Complete post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

3.6 CLEANING

A. Clean roofing surfaces free of overspray materials. Remove excess materials.

B. Re-install materials which may have been removed during the Work and ensure them to be in working order.

END OF SECTION 075600

SECTION 076200 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 through Division 26 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Qualifications, Standards and Materials for sheet metal flashing.
2. Fasteners.

B. Related Sections:
1. Section 061050 - Roof Carpentry
2. Section 075216 - Modified Bitumen Roof System
3. Section 075220 - Roofing Installer's Warranty
4. Section 075600 - Fluid Applied Membrane Flashing
5. Section 077200 - Roof Accessories

1.3 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Metal Edge Securement: Except gutter, shall be installed as tested in accordance with the most current version of the ANSI\SPRI ES-1, American National Standard for Edge Systems Used with Low-Slope Roofing Systems.

C. Thermal Movements: Provide sheet metal roofing that allows for thermal movements resulting from ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.

D. Water Infiltration: Provide sheet metal roofing that does not allow water infiltration to building interior, with metal flashing and connections of sheet metal roofing lapped to allow moisture to run over and off the material.

1.4 SUBMITTALS

A. Comply with provisions of Division 01.

B. Mark each product data cut-sheet by circling or highlighting and affix the corresponding Article and Paragraph designations from this Specification Section.

Product data not so

marked will be returned without review, for re-submittal complying with the above requirements.

C. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes, as follows:
1. Galvanized sheet metal.
2. Stainless sheet metal.
3. Prefinished sheet metal.
4. Aluminum sheet metal.
5. Self-adhered underlayment.
6. Fasteners.
7. Lead drain flashing.
8. Lead vent flashing.
9. Asphalt roofing cement.
10. Sealant.
11. Solder.

D. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
1. Identification of material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
4. Details of termination points and assemblies, including fixed points.
5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
7. Details of special conditions.
8. Details of connections to adjoining work.
9. Detail formed flashing and trim at a scale of not less than 3 inches per 12 inches.

E. If the Contractor intends to comply – without deviation – with the Contract Drawings, shop drawings will not be required as part of this Section. Contractor shall include with initial submittals a letter confirming Contractor's intent to comply with the Drawings, or:
1. Should any changes form the Drawings be anticipated – for whatever reason – submit detailed and accurate to-scale shop drawings, showing the changes and including components.
2. Include the date, project name and Drawing Detail number of the detail proposed for change.

F. Samples and Color Charts for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.

G. Submit sample prefinished metal color warranty.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups including but not limited to, typical roof eave, fascia, gutter, coping, scupper, collector head and downspouts, approximately 10 feet long or per individual item, including supporting construction cleats, seams, attachments and accessories.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Pre-installation Conference:
   1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
   2. Review methods and procedures related to sheet metal flashing and trim.
   3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
   4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
   5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.7 WARRANTY

A. Warranty on Prefinished Metal: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Sheet Metal Types:
1. Galvanized Steel: Lock-forming quality G90, meeting ASTM A-653, in 12-, 22- and 24-gauge thickness, unless otherwise indicated below or on the Drawings.
2. Stainless Steel: 24-gauge, ASTM A240, Type 304, fully annealed for fabrication of receivers for rooftop mechanical equipment where shown on the drawings.
3. Prefinished Metals: 24-gauge, Galvalume® steel, treated, primed and prefinished under precision conditions.
   a. Exposed Finish: Kynar 500® Fluorocarbon coating. Bottom or unexposed side: manufacturer's standard primer coat. Use for metals indicated on the Drawings and shown hereafter to be exposed to view, and not designated for other metal types.
   b. Color: Color selection by Architect and/or Owner from manufacturer's standard colors unless custom colors are indicated elsewhere in the Contract Documents.
   c. Provide pre-finished metal with manufacturer's standard twenty (20) year finish warranty.
   d. Deliver pre-finished metal to site with factory-applied protective plastic film, to be removed immediately upon installation.

2.2 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
3. Products: Subject to compliance with requirements, provide one of the following:
   a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
   b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

C. Fastener Types:
1. Blind Rivets: Stainless steel, Series 44. Rivet and mandrel: Stainless steel. Use

stainless steel pop rivets for galvanized, stainless steel, copper and pre-finished metals.

2. Exposed Fasteners: Exposed fasteners to receive metal-jacketed neoprene or EPDM washers.
   a. Sheet metal fasteners shall be stainless steel.
   b. Omit washers where fasteners attach counterflashing to receivers, straps to gutters and downspouts to walls.
   c. Exposed horizontal surface fasteners are unacceptable.
   d. Other cleats, screws, rivets, bolts, etc.: Matching material to which they attach, or be galvanically compatible to the surface to which they are secured.
3. Neoprene-Head Screws: #10 or #12 stainless steel screws, with hexagonal heads and matching color metal jacketed neoprene rubber washer.
4. Stainless Steel Masonry Nailer Washers: EPDM sealing washers bonded to Type 304 stainless steel jackets; Rawl EPDM Sealing Washers or approved equal; 3/4-inch diameter.
5. Steel Masonry Nails: Steel pin and zinc-jacketed fastener; Zamac “Hammer Screw,” or approved equal. Size: 1/4-inch x 1-1/2 inches.
6. Roofing Nails:
   a. Stainless steel for fastening into treated lumber.
   b. Size as required to suit application; minimum 11-gauge with 3/8-inch diameter head.
7. For Galvanized Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153 or ASTM F2329.
8. For Stainless Steel Sheet: Series 300 stainless steel.

D. Miscellaneous Sheet Metal-Related Materials:
1. Lead Drain Flashing: 36” x 36” x 4# sheet lead.
2. Lead Vent Flashings: 4# sheet lead preformed vent flashing with 4-inch-wide roof flange, minimum finished height of 8 inches above roof surface, and minimum 1-inch turn down into top of pipe.
3. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.
4. Sealant: Sonneborn NP-1, or an approved equal. One component urethane gun-grade sealant, meeting ASTM C-920, Type S, Grade NS.
5. Solder:
   a. Galvanized steel: ASTM B32, Grade Sn50, 50% tin and 50% lead.
   b. Stainless steel: ASTM B32, Grade Sn60 or Sn96, with acid flux of type recommended by stainless steel sheet manufacturer.
   c. Aluminum: ASTM B907, 60% tin and 40% zinc.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

1. Obtain field measurements for accurate fit before shop fabrication.

C. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

1. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

D. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in SMACNA.

E. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant.

F. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.

G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal or as shown in the drawings.

2.5 SHEET METAL FABRICATIONS

A. Galvanized Sheet Metal Items:
1. General: Where applicable, match existing screw and nail attachments with fasteners that are one size larger than existing.
2. Counterflashings and Receivers (except at Rooftop Units): Attach receivers as shown on Drawings and noted hereafter. Attach counterflashings to receivers with sheet metal screws spaced at 16 inches on centers or as indicated on Contract Drawings.
3. Hook Strips: Minimum 22-gauge. Nail at 8 inches on centers, with roofing nails.
4. Termination Bars: 12-gauge or 1/8-inch x 1 inch hot-dipped galvanized bar stock fastened with specified drive pins spaced at 12 inches on centers with minimum ¾-inch embedment.
5. Downspout Boots: 12-gauge with continuous welded or seamed connection.
   a. Anchor to walls with 12-gauge x 2-inch straps placed top and bottom of boot, and at mid-point when boots exceed 72 inches in length.
   b. Anchor straps to masonry walls with 1/4-inch expansion sleeve bolts.
   c. Anchor brackets to boot with four (4) stainless steel sheet metal screws, length as required, per bracket. Provide two (2) screws each side, anchoring bracket to boot.
   d. Make boots 96-inches maximum length and include required bends, changes in direction and other accompaniments as required by the Work.
6. Downspout Drops: 24-gauge with joints fully soldered.

B. Stainless Steel Sheet Metal items:
1. General: Where applicable, match existing screw and nail attachments with fasteners that are one size larger than existing.
2. Counterflashings and Receivers at Rooftop Units: Where shown on the Drawings, attach counterflashings to receivers with sheet metal screws spaced at 16-inches on center.
3. Equipment Curb Caps: Joints fully soldered. Attach to curbs per Drawings.
4. Flanged Vents: Joints fully soldered.
   a. Provide with minimum 4-inch-wide flange for stripping into new roofassembly.

b. Attach flange to substrate wood blocking with stainless steel roofing nails spaced at 3-inches on center, staggered.

5. Metal Splash Pans: 24-gauge, galvanized steel, formed to shape shown on Drawings.

C. Pre-Finished Sheet Metal Items:
1. General: Where applicable, match existing screw and nail attachments with fasteners that are one size larger than existing.
2. Copings: Hook at outside face on continuous 22-gauge galvanized cleat. Secure back leg with neoprene-head screws at 12 inches on centers. Provide 1-inch-high standing seams at corners and joints.
3. Counterflashings except at Rooftop Units & Exhaust Fans: Attach receivers as shown in Drawings and noted hereafter. Attach counterflashings to receivers with sheet metal screws spaced at 16 inches on centers.
4. Gutters: Fastened at 6 inches on center to substrate wood nailers with stainless steel wood screws and having 12-gauge x 1-inch galvanized steel straps spaced at 30 inches on centers. Straps shall be anchored with stainless steel sheet metal screws to gutter front edge and back face.
5. Downspouts: Transition from downspout to gutter with 24-gauge galvanized fully soldered drops.
   a. Attach downspouts to masonry walls with 12-gauge x 1-inch galvanized steel "U" shaped brackets with two (2) zinc-jacketed masonry drive pins per bracket.
   b. Anchor brackets to downspouts with four (4) stainless steel sheet metal screws, 1/2-inch maximum length, per bracket. Provide two (2) screws each side, anchoring bracket to downspout. Space brackets uniformly at 60 inches on centers
   c. Extend minimum 2-inches into downspout boots. Cover straps with prefinished metal.
6. Downspout Boot Covers: Wrap new downspout boots with continuous sheet of pre-finished metal.
7. Expansion Joint Covers.
8. Expansion Joint Hook Strips (Cleats): Attach with neoprene-head screws spaced at 12 inches on centers.
9. Fascia Metal Below Edge Metal: Hook at face on continuous 22-gauge galvanized cleat and nail upper flange at 12-inches on centers, with specified roofing nails. Lap joints 3 inches, with concealed sealant pressed between components. Do not rivet or otherwise fix laps.
10. Edge Metal and Cover Plates: Hook at face on continuous 22-gauge galvanized cleat and nail flange at 3-inches on centers, staggered, with stainless steel roofing nails.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Coordinate sheet metal Work with other roofing Work and other trades on this Project with correct sequencing of items making up the entire Project.

B. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. General: Install underlayment as indicated on Drawings.

B. Self-Adhering Sheet Underlayment:
1. Install self-adhering sheet underlayment, wrinkle free.
2. Apply primer if required by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6-inches staggered 24-inches between courses.
5. Overlap side edges not less than 3-1/2 inches.
6. Roll laps with roller.
7. Cover underlayment within 14 days.

3.3 INSTALLATION

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
4. Install sealant tape where indicated.
5. Torch cutting of sheet metal flashing and trim is not permitted.

B. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10-feet with no joints allowed within 24-inches of corner or intersection. Expansion joint covers, expansion breaks or other devices needing these shall be fitted with watertight standing seam joints allowing for lateral expansion as dictated by gauge of metal, "stretch out" or exposure, and latest printed SMACNA guidelines and criteria.

C. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.

D. Rivets: Rivet joints connected by stainless steel rivets spaced at 2-inches on center where indicated and where necessary for strength.

E. Splash Pans: Anchor to downspouts with 24 ga. X 1-inch galvanized straps with pop

rivets. Adhere splash pan to granular surfaced traffic pad set in full bed of flashing cement.

F. Metal flanges, flashings and other metal items in contact with bituminous roof assembly are to be completely primed with asphalt cut back type primer and, as applicable, set in uniform bed of plastic cement for horizontal surfaces or flashing cement for vertical surfaces.
   1. Strip-in metal flanges with specified stripping plies on the same day they are installed.
   2. When gutters are included in the roof edge assembly, the gravel guard metal must be installed simultaneously with the gutter and flashed with specified stripping plies on the same day they are installed.

G. Joints, other than those receiving standing seam or cover and back plates, in galvanized sheet metal edgings, accessories, flanges and umbrellas, etc. shall be connected by stainless steel blind rivets spaced at 2 inches on center and fully soldered completely watertight.

H. Fabricate new metal in longest practical lengths up to ten feet, to minimize joints.

I. Counterflashing and receiver joints shall be lapped a minimum of 4 inches and have a 1/4-inch bead of sealant pressed between the pieces.
   1. The sealant shall not be visible from the exterior.
   2. The bottom hemmed edge of the counterflashing shall be neatly hooked in bayonet fashion.
   3. Metal counter-flashings shall completely cover fasteners used to hold in place top terminations of composition base flashings.

J. Install sheet metal flashings and accessories in accordance with the latest printed SMACNA guidelines and in accord with recognized roofing and sheet metal industry standards.
   1. Fit flashings tightly in place using square and true mitered corners.
   2. Surfaces shall be true and straight and lines accurate to profiles encountered.

K. Install new 6-inch-wide cover and backer plates at new edge metal.
   1. Fabricate of matching metal and suitable profile to ensure complete and permanent watertight integrity of metal joint.
   2. Fasten adjoining 10-foot metal gravel guard sections as per most current SMACNA requirements.
   3. New cover plates shall be set in specified sealant. Mastic shall not be used in the jointing of edge metal corners or cover and backer plates.
   4. Cover plates shall be neatly bent along the edges to hug the gravel guard over which they are installed. Gaps of more than 1/16 inch are not permitted.
   5. Nail edge metal in place not more than 3 inches on centers; in a staggered pattern.
   6. Cover plate joints shall be symmetrically laid out so that opposite end sticks of metal are of the same length with lengths in between being the same. Prepare sample layouts in the field for the Architect’s approval prior to proceeding with the Work.

L. Lay out cover plate joints symmetrically, so that opposite end sticks of metal are of the same length with lengths in between being the same. Provide sample layouts in the field for the Architect’s approval.

3.4 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in Manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces.

E. Do not use touch-up paint to cover any fasteners, metal or other component unless specifically approved in writing in advance of the Work. Any use of touch-up paint without prior approval shall result in affected components being removed and replaced at Contractor’s expense.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 through Division 26 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Pipe supports.
2. Roof curbs.
3. Equipment supports.

B. Related Sections
1. Section 075423 – Thermoplastic Polyolefin (TPO) Membrane Roofing
2. Section 076200 - Flashing and Sheet Metal
3. Section 220000 - Common Work Results for Plumbing
4. Section 230000 - Common Work Results for Mechanical
5. Section 260000 - Common Work Results for Electrical

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Structural Performance of Aluminum Ladders: Ladders, including landings shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

1.4 SUBMITTALS

A. Comply with provisions of Division 01.

B. Mark each product data cut-sheet by circling or highlighting and affix the corresponding Article and Paragraph designations from this Specification Section. Product data not so marked will be returned without review, for re-submittal complying with the above requirements.

C. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

D. Submit shop drawings for aluminum ladders.

E. Submit sample warranties for all products listed in Article 1.6.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered in bulk as necessary without hindrance of the Work.

1. Schedule and coordinate with Owner necessary deliveries to cause the least amount of inconvenience to Owner's daily activities.
2. Deliveries and unloading or loading activities shall be the responsibility of the Contractor. The Owner will not take any responsibility for Contractor's deliveries.

B. Store necessary materials in such a manner to keep from damage by elements or construction and other traffic. Storage of materials on the roof surface is prohibited without adequate blocking to prevent damage to the existing or new roof surfaces.

C. Fit accessory Work to other Work. Scribe and cope as required for accurate fit.

1.6 WARRANTY

A. Pipe Supports: Provide manufacturer's standard warranty.

B. Roof Curbs: Provide manufacturer's standard warranty.

C. Equipment Supports: Provide manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 PIPE SUPPORTS

A. General:
1. Reuse of existing pipe supports or support pads is not acceptable.
2. Construction trades including plumbing, mechanical and electrical shall provide pipe supports from the same manufacturer.
3. Piping supported on the roof surfaces shall be one of the systems specified herein, with the hardware for each system being provided by this Contractor.
4. Furnish and install curbs and flashings, traffic support pads, sheet metal flashings, etc., as required for the proper installation of these systems.
5. Piping and conduit should be elevated a minimum of 12 inches above the roof surface, unless otherwise noted.
6. Piping and conduit should be clamped down with retainer brackets or channel clamps.

B. Pipe Support – Type "A": Provide for support of single condensate lines and electrical conduit 1-1/2 inch outside diameter and less, and PVC lines.
1. Manufacturer / Model(s):
   a. nVent Caddy (ERICO), www.erico.com or approved equal.
      i. Pyramid ST Fixed Strut Support (Where positive slope is provided in structure / roofing system.)
      ii. Pyramid ST Adjustable Strut Support (Where positive slope is not provided

in structure / roofing system.)
b. OMG Roofing Products, www.omgroofing.com or approved equal.
i. OMG Pipeguard® 'Mini' (Where positive slope is provided in structure / roofing system.)
ii. OMG Pipeguard® 'Height Adjustable Strut' (Where positive slope is not provided in structure / roofing system.)
c. PHP Systems/Design, www.phpsd.com or approved equal.
i. SS8-CL (Where positive slope is provided in structure / roofing system.)
ii. SS8-C (Where positive slope is not provided in structure / roofing system.)

2. Support assembly is to be composed of:
a. Base: Molded polyethylene and/or polypropylene base with UV inhibitors.
b. Rod: Galvanized steel 1/2"Ø threaded rods, nuts and washers.
c. Channel: Galvanized steel 12-gauge perforated channel.
d. Bracket: Galvanized steel retainer bracket.
3. Space supports at maximum distance of 8'-0" on center or less to prevent sag or deflection.
4. Place supports within 12 to 18 inches of "ell" corners, pipe bends, tee intersections and below each pipe or conduit joint.

C. Pipe Support – Type "B": Provide for support of single hydronic pipe and gas pipe and multiple (3 maximum) electrical conduit 2 inch outside diameter and less.
1. Manufacturer / Model(s):
a. PHP Systems/Design, www.phpsd.com or approved equal.
i. Hydronic Pipe: PP-10-R with roller support and insulation shield.
ii. Gas Pipe: PP-10-R with roller support.
ii. Electrical Conduit: PP-10-C with channel.
2. Support assembly is to be composed of:
a. Base: Molded high density/high impact polypropylene base with UV inhibitors and antioxidants.
b. Base Footprint: 10" x 16" minimum.
c. Rod: Galvanized steel 1/2"Ø threaded rods, nuts and washers.
d. Roller: Cast iron roller with malleable sockets (gas pipe only). Nylon or synthetic compound rollers are not acceptable.
e. Channel: Galvanized steel 12-gauge perforated channel (electrical conduit only).
f. Bracket: Galvanized steel retainer bracket.
g. Insulation Shield: Galvanized steel.
3. Space supports at maximum distance of 8'-0" on center or less to prevent sag or deflection where piping or conduit is greater than 1-1/4 inches outside diameter.
4. Space supports at maximum distance of 6'-0" on center or less to prevent sag or deflection where piping or conduit is equal to or less than 1-1/4 inches outside diameter.
5. Place supports within 12 to 18 inches of "ell" corners, pipe bends, tee intersections and below each pipe or conduit joint.
6. Provide retainer bracket to prevent pipe from lifting from the rollers.

D. Pipe Support – Type "C": Provide for support of single or multiple hydronic pipes / gas piping / electrical conduit in excess of 3-1/2 inch outside diameter.
1. Manufacturer / Model(s):
a. Eaton (formerly Cooper Industries), www.eaton.com or approved equal.
i. B-Line Series base/pipe stand, adjusters and supports, as detailed.

ii. Provide insulation shield for hydronic piping.

2. Support assembly is to be composed of:
   a. Frame: Galvanized steel 12-gauge perforated channel with galvanized brackets welded to strut and mounted with galvanized steel bolts through neoprene washers into metal-capped curb assembly.
   b. Rod: Galvanized steel 1/2"Ø threaded rods, nuts, axle and retainer bracket.
   c. Roller: Cast iron roller with malleable sockets. Nylon or synthetic compound rollers are not acceptable.
   d. Bracket: Galvanized steel retainer bracket.
   e. Insulation Shield: Galvanized steel.
3. Space supports at maximum distance of 8'-0" on center or less to prevent sag or deflection.
4. Place supports within 12 to 18 inches of “ell” corners, pipe bends, tee intersections and below each pipe or conduit joint.

E. Pipe Support Protection Pads:
1. Type A: Protection pad below pipe support base.
   a. Derbigum — Derbicolor P FR
   b. Johns Manville — DynaWeld Cap FR
   c. Siplast — Paradiene 30 FR
   d. Soprema — Elastophene Flam FR
   e. U.S. Ply — DuraFlex G4 FR SBS
2. Type B & C: Protection pad below pipe support base.
   a. Derbigum — Derbicolor P FR (2 layers)
   b. Johns Manville — DynaTred
   c. Siplast — ParaTread
   d. Soprema — Sentinel
   e. U.S. Ply — USP SBS Walkboard

2.2 ROOF CURBS

A. Pre-manufactured Steel Curbs: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings.
1. Manufacturer: Thybar Corp., www.thybar.com or approved equal.
2. Model: Model TC-3.
3. Shop Fabrication: Shop fabricated curbs are not acceptable.
4. Coordinate with Mechanical Contractor as to which mechanical equipment is being provided with pre-manufactured curbs. If so, those curbs shall be installed by the Mechanical Contractor; flashing, counterflashing and sealing of roof system to the curbs shall be by Roofing Contractor.

B. Construction:
1. Frames: 18-gauge G90 hot-dipped galvanized sheet steel and base plate with joints fully welded complying with ASTM A653. Bolted connections are not acceptable.
2. Wood Nailers: Factory installed; pressure treated. Size and width as suitable for support of mechanical equipment mounted on curbs.
3. Reinforcement: Internally reinforce curbs exceeding 3-foot length and as required to support mechanical equipment.
4. Gasketing: ¼-inch thick x 1-inch wide at rooftop units.
5. Counterflashing: As indicated on the drawings.

6. Insulation: 1-1/2” thick 3-pound density rigid insulation.
7. Curb Height: Coordinate curb height to comply with roofing drawings. Minimum height above roof surface shall be measured from the highest side of sloped roof.
8. Roof Slope: Curbs shall be constructed to match roof slope with plumb and level top surface for mounting mechanical equipment.

2.3 EQUIPMENT SUPPORTS

A. Equipment Supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings.
1. Manufacturer: Thybar Corp., www.thybar.com or approved equal.
2. Model: Model TEMS-3.
3. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
4. Shop Fabrication: Shop fabricated equipment supports are acceptable if they meet the requirements of the specifications and drawings.
5. Coordinate with mechanical contractor to determine if any equipment supports are being furnished with respective equipment. If so, those curbs shall be installed by the Mechanical Contractor; flashing, counterflashing and sealing of roof system shall be by Roofing Contractor.

B. Construction:
1. Material: Galvanized steel sheet, 18 gauge with welded joints.
2. Insulation: Fill curb with fiberglass batt insulation.
3. Factory-installed continuous wood nailers at tops of equipment supports.
4. Provide a 24-gauge galvanized sheet metal cap with fully soldered or welded joints.
   a. Secure caps with stainless steel screws with neoprene-head washers spaced at 16-inches on center max. with a minimum of two screws on each side.
   b. Curb sides with dimensions of less than 8 inches require one fastener per side.
5. Fabricate equipment supports to minimum height of 12 inches above the finished high side roof surface unless otherwise indicated.
6. Roof Slope: Equipment supports shall be constructed to match roof slope with plumb and level top surface for mounting equipment.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Inspect existing conditions to determine that Work preceding this installation is as intended and is of sound construction. Proceeding with the Work of this Section indicates acceptance of conditions.

B. Installations shall be in accordance with the manufacturer’s printed instructions and as

shown on the Drawings.

3.2 PIPE SUPPORT INSTALLATION

A. Non-Penetrating Pipe Supports (Types A & B):
1. Assemble pipe supports with protection pad as shown on the Drawings. Adhere supports solid to protection pads in specified sealant.
2. Set pad assemblies on the roof membrane. Do not adhere to roof system.
3. Securely strap electrical conduit or Unistrut carrying electrical conduit to supports with galvanized steel straps.
4. Loosely strap gas piping to support with galvanized steel straps. Straps shall allow free movement of piping, but not allow piping to lift more than 1 inch from support.

B. Penetrating Curbed Roller Pipe Supports (Type C):
1. Anchor new curbs to existing deck or wood blocking using #12 coated insulation screws spaced at 8 inches on center, or a minimum of two per side.
2. Flash curbs to the roof per the respective Section.
3. Set new galvanized metal caps as shown on the Drawings.
4. Set new roller assemblies and anchor securely to curbs with neoprene-head screws.
5. Strap tops of pipes to roller assemblies.

3.3 OTHER ASSEMBLY INSTALLATION

A. Equipment Supports and Curbs: Anchor supports and curbs to deck or wood blocking as shown on the Drawings using #12 coated insulation screws or lag bolts spaced at 8-inches on centers, or minimum of two per side.

B. Other Assemblies: Install as indicated on the Drawings, as required by the manufacturer or as designated above.

3.4 CLEANING

A. Clean items of this Section in accordance with the respective manufacturer’s instructions.

END OF SECTION 077200

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Acoustical joint sealants.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers four samples of materials that will contact or affect joint sealants. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

D. Product test reports.

E. Preconstruction compatibility and adhesion test reports.

F. Preconstruction field-adhesion test reports.

G. Field-adhesion test reports.

H. Warranties.

1.4 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Minimum Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SILICONE JOINT SEALANTS

A. Mildew-Resistant Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BASF Building Systems.
    b. Dow Corning Corporation.
    c. GE Advanced Materials - Silicones.
    d. May National Associates, Inc.
    e. Pecora Corporation.
    f. Polymeric Systems, Inc.
    g. Schnee-Morehead, Inc.
    h. Sika Corporation; Construction Products Division.
    i. Tremco Incorporated.

2. Type: Single component (S).
3. Grade: Nonsag (NS).
4. Class: 100/50.
5. Uses Related to Exposure: Nontraffic (NT).

2.3 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BASF Building Systems.
    b. Bostik, Inc.
    c. Lymtal, International, Inc.
    d. May National Associates, Inc.
    e. Pacific Polymers International, Inc.
    f. Pecora Corporation.
    g. Polymeric Systems, Inc.
    h. Schnee-Morehead, Inc.
    i. Sika Corporation; Construction Products Division.
    j. Tremco Incorporated.

2. Type: Single component (S) or multicomponent (M).
3. Grade: Pourable (P) or nonsag (NS).
4. Class: 100/50.
5. Uses Related to Exposure: Traffic (T).

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BASF Building Systems.
    b. Bostik, Inc.
    c. May National Associates, Inc.
    d. Pecora Corporation.
    e. Schnee-Morehead, Inc.
    f. Tremco Incorporated.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Pecora Corporation.
    b. USG Corporation.

2.6 JOINT SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:
   a. Isolation and contraction joints in cast-in-place concrete slabs.
   b. Tile control and expansion joints.
   c. Joints between different materials listed above.

2. Joint Sealant: Urethane.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surface.

1. Joint Locations:
   a. Control and expansion joints in unit masonry.
   b. Joints between metal panels.
   c. Joints between different materials listed above.
   d. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
   e. Control and expansion joints in ceilings and other overhead surfaces.
2. Joint Sealant: Urethane.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

   a. Isolation joints in cast-in-place concrete slabs.

b. Control and expansion joints in tile flooring.

2. Joint Sealant: Urethane.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings.
c. Tile control and expansion joints.
d. Vertical joints on exposed surfaces of interior unit masonry, concrete, walls and partitions.
e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.

2. Joint Sealant: Latex.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Sealant Location:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.

2. Joint Sealant: Silicone.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Location:

a. Acoustical joints.

2. Joint Sealant: Acoustical.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airtec Corporation.
2. Apex Industries, Inc.
3. Baron Metal Industries Inc.; an Assa Abloy Group company.
4. Ceco Door; ASSA ABLOY.
5. Concept Frames, Inc.
6. Curries Company; ASSA ABLOY.
7. Daybar Industries, Ltd.
8. DCI Hollow Metal.
9. DE LA FONTAINE.
10. Deansteel Manufacturing Company, Inc.
11. Deronde Products.
12. Megamet Industries, Inc.
13. Mesker Door Inc.
14. Metropolitan Door Industries Corp.
15. Philipp Manufacturing Co (The).
16. Pioneer Industries.
17. Premier Products, Inc.
18. Republic Doors and Frames.
19. Rocky Mountain Metals, Inc.
20. Security Metal Products; a brand of ASSA ABLOY.
21. Steelcraft; an Allegion brand.
22. Steward Steel Door & Frame Division.
23. Stiles Custom Metal, Inc.
24. Titan Metal Products.
25. Trillium Steel Doors Limited.
26. West Central Manufacturing, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. (2.84 W/K x sq. m) when tested according to ASTM C518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches (44.5 mm).
   c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
   d. Edge Construction: Model 2, Seamless.
   e. Core: Manufacturer's standard.
   f. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.

2. Frames:

   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
   b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: Knocked down.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. [At locations indicated in the Door and Frame Schedule] <Insert locations>.

1. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches (44.5 mm).
   c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
   d. Edge Construction: Model 2, Seamless.

e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: Manufacturer's standard.
h. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
b. Construction: Full profile welded.

2.5 BORROWED LITES

A. Fabricate of metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).

B. Construction: Full profile welded.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.7 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.8 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with post installed expansion anchors.
4. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions, door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.3 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

1.1 GENERAL

A. Submittals: In addition to Product Data for each type of acoustical panel and suspension system required, submit the following:

1. 6-inch- square samples of each acoustical panel type, pattern, and color.

2. Set of 12-inch- long samples of exposed suspension system members, including moldings, for each color and system type required.

B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Fire-response tests were performed by UL, ITS/Warnock Hersey, or another independent testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
2. Fire-resistance-rated assemblies, which are indicated by design designations from UL's "Fire Resistance Directory," from ITS/Warnock Hersey's "Directory of Listed Products," or from the listings of another testing and inspecting agency, are identical in materials and construction to those tested per ASTM E 119.
3. Products are identified with appropriate markings of applicable testing and inspecting agency.

1.2 PRODUCTS

A. Mineral-Base Panels - Nodular, Cast or Molded; with Painted Finish: Type III, Form 1 units per ASTM E 1264 complying with the following:

1. Fissured Pattern: Units matching pattern indicated by reference to manufacturer's standard pattern designations, and as follows:

a. Color: Match Architect's sample. (white)
b. Noise Reduction Coefficient: NRC 0.50 - 0.60.
c. Ceiling Sound Transmission Class: CSTC 35.
d. Edge Detail: Square.
e. Size: 24 inches by 24 inches by 5/8 inch.

2. Products: Subject to compliance with requirements, provide one of the following:

a. Food Service Areas:
   a. “Kitchen Zone”, Armstrong Ceilings, #673 Vinyl-Laminated Lay-In gypsum ceiling panels.

A. Metal Suspension System: Manufacturer's standard direct-hung suspension system complying with applicable ASTM C 635 requirements and with requirements indicated below:

B. Direct-Hung Suspension Systems: As follows, with hangers, attachment devices, and edge moldings and trim.

C. Wide-Face capped Double-Web Steel Suspension System: Runners roll-formed from pre-painted or electrolytic zinc-coated cold-rolled steel sheet, with prefinished 15/16 inch wide metal caps on flanges; and as follows:

   a. Structural Classification: Intermediate-Duty System.

D. Cap Material and Finish: Steel painted in color selected from manufacturer's standard color line.

E.

Manufacturer	Suspension System
USG Interiors, Inc.: Donn	DXL Series
Armstrong Ceilings	7300 Series for rated assembly

F. Finishes and Colors for Metal Suspension System, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

G. Suspension System Attachment Devices: Fabricated from corrosion-resistant materials and sized for five times design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.

H. Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.

1.3 EXECUTION

A. General: Install acoustical panel ceilings to comply with publications referenced below per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

   1. Standard for Ceiling Suspension System Installations: Comply with ASTM C 636.

B. Secure ceiling hangers from suspension system members to building's structural members. Install hangers plumb and free from contact with other objects within ceiling plenum. Connect hangers directly either to structures or to inserts, eye

screws, or other devices that are secure; that are appropriate for substrate; and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

1. Do not support ceilings directly from permanent metal forms, or floor or roof deck. Do not attach hangers to steel deck tabs.
2. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 8 inches from ends of each member.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

END OF SECTION 095113

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resinous flooring.
2. Integral cove base accessories.

1.2 COORDINATION

A. Coordinate flooring installation with the following:

1. Floor drains and drainage slopes.
2. Wall finish trim termination.
3. Curing of concrete slabs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
2. Review details of integral cove bases.
3. Review manufacturer's written instructions for installing resinous flooring systems.
4. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.

B. Sustainable Design Submittals:
Product Data: For adhesives, indicating that product contains no urea formaldehyde.
2. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Samples: For each resinous floor system required and for each color and texture specified, 4 inches (102 mm) square in size, applied to a rigid backing by Installer for this Project.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

B. Field quality-control reports.

C. Qualification Statements: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Install and finish a complete room for a mockup in Office #106.

a. Include integral cove base with inside and outside corner.

2. Simulate finished lighting conditions for Architect's review of mockups.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials in accordance with manufacturer's written instructions.

1. Store materials in dry, enclosed areas with protection from moisture.
2. Maintain sealed containers until ready for use.

C. Storage Temperature: Store between 65 and 90 deg F (18 and 32 deg C).

1.10 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.

1. Maintain 65 to 90 deg F (18 to 32 deg C) temperature range 24 hours before, during, and 72 hours after flooring installation.

a. Maintain minimum 55 to 85 deg F (12.8 to 29.4 deg C) concrete substrate temperature.
b. Substrate temperatures to be minimum 5 deg F (minus 15 deg C) above dew point.

2. Ventilate flooring installation area.
3. Post and enforce "NO SMOKING" or "NO OPEN FLAME" signs until flooring has cured.

B. Lighting: Provide 50 fc (538 lux) of lighting during resinous flooring installation. Shade flooring from direct sunlight.

C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace flooring that fail(s) in materials within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Delamination.
b. Excessive wear or degradation of surface finish.
c. Water leakage through flooring system.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flooring products to comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Flooring products to comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions to not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

C. Flooring products to comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Flooring products to comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Flammability: Self-extinguishing in accordance with ASTM D635.

2.2 RESINOUS FLOORING

A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.

Basis-of-Design Product: Subject to compliance with requirements, provide Everlast Epoxy Systems, Inc.; Everlast Floor. No substitutions allowed.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

C. System Characteristics:

Color and Pattern: Swordfish.

2. Wearing Surface: Manufacturer's standard wearing and fine slip-resistant surface.
3. Overall System Thickness: 3/16 inch (4.8 mm).

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested in accordance with test methods indicated:

1. Compressive Strength: 17,000 psi (117 MPa) minimum in accordance with ASTM C579.
2. Tensile Strength: 7100 psi (49.0 MPa) minimum in accordance with ASTM C307.
3. Flexural Modulus of Elasticity: 10,000 psi (68.9 MPa) minimum in accordance with ASTM C580.
4. Water Absorption: 0.2 percent maximum in accordance with ASTM C413.
5. Indentation: 1 percent maximum in accordance with ASTM D2794.
6. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation up to 24,000 psi (165 MPa) in accordance with ASTM D4226.
7. Abrasion Resistance: 0.018 gm (68.9 MPa) maximum weight loss in accordance with ASTM D4060.
8. Slip Resistance:

    a. Wet Leather: Static at 1.05; sliding at 0.74.
    b. Wet Rubber: Static at 1.10; sliding at 0.72.

System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested in accordance with ASTM D1308 for 50 percent immersion.

F. Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.

    1. Products:

        a. Everlast Epoxy, Moisture Vapor Primer.

    2. Formulation Description: 100 percent solids.

G. Waterproofing Membrane: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.

    1. Products:
        a. Everlast Epoxy, Moisture Vapor Primer.

H. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended in writing by manufacturer for installation indicated.

    1. Products:

        a. Everlast Epoxy Systems, Inc.; Everlast Epoxy Underlayment.

I. Body Coats:

    1. Products:

        a. Everlast Epoxy Systems, Inc.; Everlast Floor.

    2. Resin: Epoxy.
    3. Formulation Description: 100 percent solids.
    4. Installation Method: Troweled or screeded.

5. Number of Coats: One.
6. Thickness of Coat: 5 to 10 mils (0.13 to 0.25 mm).

J. Topcoats: Sealing or finish coats.

1. Products:

a. Everlast Epoxy Systems, Inc.; Stay-Clean Sealant with standard fine anti-skid treatment.

2. Resin: Epoxy.
3. Formulation Description: 100 percent solids.
4. Type: Clear.
5. Number of Coats: One.
6. Thickness of Coats: 5 to 10 mils (0.13 to 0.25 mm).
7. Finish: Matte.

2.3 INTEGRAL COVE BASE ACCESSORIES

A. Precast, Integral Cove Base: Impact-resistant, two-part epoxy polymer-resin, three-component cove base moldings with a grit profile to promote adhesion of resinous flooring and recommended in writing by resinous flooring manufacturer.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Everlast Epoxy Systems, Inc.; Everlast Cove Base & Wall or comparable product.
2. Radius Cove: Cove molding with approximately 1-inch (25-mm) radius for adhesive installation at floor-to-wall joint as substrate to receive resinous flooring system to form an integral cove base.
3. Radius Cove Base: 6-inch- (152-mm-) high, base molding that provides approximately 1-inch (25-mm) radius cove at floor-to-wall joint; for adhesive installation as substrate for resinous flooring system to form an integral cove base.

a. Preformed Inside and Outside Corners: Provide manufacturer's standard square inside and 3/4- to 1-inch (19- to 25-mm) bullnose outside corners.

Color and Pattern: Match resinous flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges,

depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

   a. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile (CSP) not less than 1 or greater than 2 in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m) and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 80 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Perform tests recommended in writing by resinous flooring manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer,

C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.

D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

3.3 INSTALLATION

A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.

Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation and curing processes.
3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Primer: Apply primer over prepared substrate at spreading rate recommended in writing by manufacturer.

C. Field-Formed Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring coats. Apply in accordance with manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base: 6 inches (150 mm) high.

D. Troweled Body Coat: Apply troweled body coats in thickness specified for flooring system. Hand or power trowel and grout to fill voids. When body coat is cured, remove trowel marks and roughness using method recommended in writing by manufacturer.

E. Topcoats: Apply topcoats in number indicated for flooring system specified, at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.

F. Tolerances:

1. Maximum Variation from Flat Surface: 1/8 inch in 10 ft. (3 mm in 3 m).

3.4 FIELD QUALITY CONTROL

A. Material Sampling: Owner may, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with

unacceptable materials, and reinstall flooring materials to comply with requirements.

B. Core Sampling: At Owner's direction and at locations designated by Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

3.5 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Traffic over newly finished floor surfaces is not permitted for 42 hours. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on exterior substrates.

1. Concrete.
2. Clay masonry.
3. Concrete masonry units (CMU).
4. Steel.
5. Galvanized metal.
6. Aluminum (not anodized or otherwise coated).
7. Wood.
8. Exterior portland cement plaster (stucco).
9. Exterior gypsum board.

1.2 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples: For each type of paint system and each color and gloss of topcoat.

C. Product List: For each product indicated. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated.

B. Acceptable Manufacturers:
1. ICI
2. Pittsburgh Paint
3. Sherwin Williams

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

D. Colors: As indicated in Finish Schedule.

2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior:

1. SW: Loxon, Block Surfacer.

2.4 PRIMERS/SEALERS

A. Primer, Alkali Resistant, Water Based:[MPI #3.]

1. Sherwin Williams, Loxon Exterior Concrete and Masonry Primer, #A24W8300.

2.5 METAL PRIMERS

A. Primer, Alkyd, Anti-Corrosive for all Metal: [MPI #79]

1. Sherwin Williams, Water Based Rust Inhibited Primer, Pro Industrial Pro-Cryl Universal Metal Primer.

2.6 WOOD PRIMERS

A. Primer, Latex for Exterior Plywood:

1. Sherwin Williams, Exterior Latex Wood Primer, B42W8041

B. Primer, Oil for Exterior Wood:[MPI #7]
1. ICI: #2110-1200.
2. Pittburgh: Speedhide exterior oil based primer.
3. SW: A-100 Exterior oil wood primer, Y24W8020.

2.7 WATER-BASED PAINTS

A. Waterproof Masonry Coating

1. SW: Loxon XP, Waterproof Masonry Coating #LX01W0200
   a. Provide manufacturers extended 10 year warranty.
2. Pittsburgh: Approved equal

B. Latex, Exterior Flat (Gloss Level 1):[MPI #10.]
1. ICI:#2416
2. Pittsburgh: Speedhide exterior semi-gloss latex, 6-900 Series.
3. SW: A-100 Exterior latex.

C. Latex, Exterior Semi-Gloss (Gloss Level 5):[MPI #11]
1. ICI:#2416
2. Pittsburgh: Speedhide exterior semi-gloss latex, 6-900 Series.
3. SW: A-100 Exterior latex.

D. Light Industrial Coating, Exterior, Water Based, Semi-Gloss (Gloss Level 5):[MPI #163.]

1. Sherwin Williams, DTM Acrylic

2.8 SOLVENT-BASED PAINTS

A. Alkyd, Exterior Gloss (Gloss Level 6) for metal handrails, doors and bollards:[MPI #9.]

1. Sherwin Williams, Pro Industrial Urethane Alkyd, #B54W151.

2.9 ALUMINUM PAINT

A. Aluminum Paint, 100% Acrylic D.T.M.: [MPI#1]
1. ICI: Devflex 4208 Series.
2. Pittsburgh: 90-Line Finish.
3. SW: Bondplex Waterbased Acrylic Aluminum, B71S200.

2.10 FLOOR COATINGS

A. Sealer, Solvent Based, for Concrete Floors:[MPI #104.]

1. Sherwin Williams, Concrete and Terrazzo Sealer, A44 Series.

B. Floor Enamel, Alkyd, Satin; [MPI #27.]

1. Sherwin Williams, H&C, Concrete Stain & Sealer w/”Sharks Grip” Slip Resistant Additive

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Portland Cement Plaster: 12 percent.
5. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Waterproof Masonry Coating:

a. Prime Coat: A. Block Filler, Latex, exterior, if required.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior gloss (Gloss Level 1), MPI #10.

B. Concrete Substrates, Traffic Surfaces:

1. Alkyd Floor Enamel System:

a. Prime Coat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
b. Intermediate Coat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
c. Topcoat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Solvent-Based Clear Sealer System:

a. Prime Coat: Sealer, solvent based, for concrete floors[, MPI #104].
b. Intermediate Coat: Sealer, solvent based, for concrete floors[, MPI #104].
c. Topcoat: Sealer, solvent based, for concrete floors[, MPI #104].

C. CMU/Masonry/Tile Substrates:

1. Waterproof Masonry Coating:
a. Prime Coat: A. Block Filler, Latex, exterior, if required.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior gloss (Gloss Level 1), MPI #10.

D. Steel Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, alkyd, anti-corrosive for metal[, MPI #79].
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.

c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5)[, MPI #163].

2. Aluminum Paint System:

a. Prime Coat: Primer, alkyd, anti-corrosive for metal[, MPI #79].
b. Intermediate Coat: Aluminum paint[, MPI #1].
c. Topcoat: Aluminum paint[, MPI #1].

E. Galvanized-Metal Substrates:

1. Latex System:

2. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, galvanized, water based[, MPI #79].
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5)[, MPI #163].

F. Wood Substrates: Including wood trim, architectural woodwork, doors, windows, wood siding, wood-based panel products, glued-laminated construction, exposed joists & exposed beams.

1. Latex over Alkyd Primer System:
a. Prime Coat: Primer, oil for exterior wood[, MPI #7].
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior semi-gloss (Gloss Level 5)[, MPI #11].

G. Portland Cement Plaster Substrates:

1. Waterproof Masonry Coating:
a. Prime Coat: A. Block Filler, Latex, exterior, if required.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior gloss (Gloss Level 1), MPI #10.

H. Exterior Gypsum Board Substrates:

1. Latex System:

a. Prime Coat: Latex, exterior, matching topcoat.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior semi-gloss (Gloss Level 5)[, MPI #11].

I. Exterior Cement Board Substrates:
1. Waterproof Masonry Coating:
a. Intermediate Coat: Latex, exterior, matching topcoat.
b. Topcoat: Latex, exterior gloss (Gloss Level 1), MPI #10.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete.
2. Clay masonry.
3. Concrete masonry units (CMU).
4. Steel.
5. Cast iron.
6. Galvanized metal.
7. Aluminum (not anodized or otherwise coated).
8. Wood.
9. Gypsum board.
10. Plaster.

1.2 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples: For each type of paint system and in each color and gloss of topcoat.

C. Product List: For each product indicated. Include printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide productBy one of the following:

1. Sherwin Williams
2. Pittsburgh Paint
3. ICI

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Colors: As indicated on Finish Schedule.

2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior:[MPI #4.]

1. Sherwin Williams Pro Mar Block Filler, B25W25.

2.4 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior:[MPI #50.]

1. Sherwin Williams Pro Mar 200 Latex Primer.

B. Primer, Alkali Resistant, Water Based:[MPI #3.]

1. Sherwin Williams Loxon Concrete & Masonry Primer, A24W8300.

C. Primer Sealer, Interior, Institutional Low Odor/VOC:[MPI #149.]

1. Sherwin Williams Pro Mar 200 Zero VOC Primer, B28W2600.

D. Primer, Latex, for Interior Wood:[MPI #39.]

1. Sherwin Williams Multi Purpose Latex Primer, B31W8020.

E. Primer Sealer, Alkyd, Interior:[MPI #45.]

1. Sherwin Williams Pro Block Alkyd Primer, B79W8810.

F. Primer, Bonding, Water Based:[MPI #17.]

1. Sherwin Williams Adhesion Primer, B51W8050.

2.5 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based:[MPI #107.]

1. Sherwin Williams Pro Industrial Pro-Cryl Universal Primer, B66W310.

B. Primer, Alkyd, Anti-Corrosive, for Metal:[MPI #79.]

1. Sherwin Williams Kem Kromik Primer, B50NZ2.

C. Primer, Galvanized, Water Based:[MPI #107.]

1. Sherwin Williams Pro Industrial Pro-Cryl Universal Primer, B66W310.

D. Primer, Quick Dry, for Aluminum:[MPI #107.]

1. Sherwin Williams Pro Industrial Pro-Cryl Universal Primer, B66W310.

2.6 WATER-BASED PAINTS

A. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1):[MPI #143.]

1. Sherwin Williams Pro Mar 200 Zero VOC Latex Flat, B30W2600.

B. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 2):[MPI #144.]

1. Sherwin Williams Pro Mar 200 Zero VOC Latex Low Sheen, B24W2600.

C. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 3):[MPI #145.]

1. Sherwin Williams Pro Mar 200 Zero VOC Latex Eg-Shel, B20W2600.

D. Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (Gloss Level 5):[MPI #147.]

1. Sherwin Williams Pro Mar 200 Zero VOC Latex Semi-Gloss, B31W2600.

E. Latex, Interior, High Performance Architectural, (Gloss Level 2):[MPI #138.]

1. Sherwin Williams Pro Mar 200 Zero VOC Latex Gloss, B21W2251.

F. Latex, Interior, High Performance Architectural, Semi-Gloss (Gloss Level 5):[MPI #141.]

1. Sherwin Williams Pro Industrial Zero VOC Semi-Gloss, B66W600 Series.

G. Light Industrial Coating, Interior, Water Based (Gloss Level 3):[MPI #151.]

1. Sherwin Williams Pro Industrial Pre-Catalyzed Epoxy Eg-Shel, K45.

H. Light Industrial Coating, Interior, Water Based, Semi-Gloss (Gloss Level 5):[MPI #153.]

1. Sherwin Williams Pro Industrial Pre-Catalyzed Epoxy Semi-Gloss, K46.

I. Light Industrial Coating, Interior, Water Based, Gloss (Gloss Level 6):[MPI #154.]

1. Sherwin Williams Pro Industrial Zero VOC Gloss, B66W600 Series.

2.7 DRY FOG/FALL COATINGS

A. Dry Fall, Latex, Flat:[MPI #118.]

1. Sherwin Williams Waterborne Acrylic Dryfall, B42.

B. Dry Fall, Water Based, for Galvanized Steel, Flat (Gloss Level 1):[MPI #118.]

1. Sherwin Williams Waterborne Acrylic Dryfall, B42.

2.8 FLOOR COATINGS

A. Stain, Interior, for Concrete Floors:[MPI #58.]

1. Sherwin Williams H&C Silicone Concrete Sealer.

B. Sealer, Water Based, for Concrete Floors:[MPI #99.]

1. Sherwin Williams H&C Concrete Waterproofing Sealer.

C. Sealer, Solvent Based, for Concrete Floors:[MPI #104.]

1. Sherwin Williams Concrete & Terrazzo Sealer, B44V22.

D. Floor Paint, Latex, Low Gloss (Maximum Gloss Level 3):[MPI #60.]

1. Sherwin Williams Armor Seal TreadPlex WB Floor Coating, B90.

E. Floor Epoxy, Gloss (Gloss Level 6):[MPI #212.]

1. Sherwin Williams Armor Seal 1000 HS Epoxy, B67W2000.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Water-Based Light Industrial Coating System:

    a. Prime Coat: Primer, alkali resistant, water based[, MPI #3].
    b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
    c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

B. Concrete Substrates, Traffic Surfaces:

1. Latex Floor Enamel System:

    a. Prime Coat: Floor paint, latex, low gloss (maximum Gloss Level 3)[, MPI #60].
    b. Intermediate Coat: Floor paint, latex, low gloss (maximum Gloss Level 3)[, MPI #60].
    c. Topcoat: Floor paint, latex, low gloss (maximum Gloss Level 3)[, MPI #60].

2. Alkyd Floor Enamel System:

    a. Prime Coat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
    b. Intermediate Coat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
    c. Topcoat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].

3. Concrete Stain System:

    a. First Coat: Stain, interior, for concrete floors[, MPI #58].

b. Topcoat: Stain, interior, for concrete floors[, MPI #58].

4. Water-Based Clear Sealer System:

a. First Coat: Sealer, water based, for concrete floors[, MPI #99].
b. Topcoat: Sealer, water based, for concrete floors[, MPI #99].

5. Solvent-Based Clear Sealer System:

a. First Coat: Sealer, solvent based, for concrete floors[, MPI #104].
b. Topcoat: Sealer, solvent based, for concrete floors[, MPI #104].

C. Clay-Masonry Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, alkali resistant, water based[, MPI #3].
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

D. CMU Substrates:

1. Water-Based Light Industrial Coating System:

a. Block Filler: Block filler, latex, interior/exterior[, MPI #4].
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

E. Steel Substrates:

1. Water-Based Dry-Fall System:
a. Prime Coat: Primer, alkyd, quick dry, for metal[, MPI #76].
b. Topcoat: Dry fall, latex, flat[, MPI #118].
c. Topcoat: Dry fall, water based, for galvanized steel, flat (Gloss Level 1)[, MPI #133].

2. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, rust-inhibitive, water based[MPI #107].
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

3. Alkyd Dry-Fall System:
a. Prime Coat: Primer, alkyd, quick dry, for metal[, MPI #76].
b. Topcoat: Dry fall, alkyd, flat[, MPI #55].

4. Aluminum Paint System:
   a. Prime Coat: Primer, alkyd, quick dry, for metal[, MPI #76].
   b. Prime Coat: Shop primer specified in Section where substrate is specified.
   c. Intermediate Coat: Aluminum paint[, MPI #1].
   d. Topcoat: Aluminum paint[, MPI #1].

F. Galvanized-Metal Substrates:
1. Latex over Waterborne Primer System:

   a. Prime Coat: Primer, galvanized, water based[, MPI #134].
   b. Intermediate Coat: Latex, interior, matching topcoat.
   c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5)[, MPI #54].

2. Water-Based Dry-Fall System:

   a. Prime Coat: Dry fall, water based, for galvanized steel, flat (Gloss Level 1)[, MPI #133].
   b. Topcoat: Dry fall, water based, for galvanized steel, flat (Gloss Level 1)[, MPI #133].

3. Water-Based Light Industrial Coating Over Waterborne Primer System:

   a. Prime Coat: Primer, galvanized, water based[, MPI #134].
   b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
   c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

4. Aluminum Paint System:

   a. Prime Coat: Primer, galvanized metal, as recommended in writing by topcoat manufacturer for use on galvanized-metal substrates with topcoat indicated.
   b. Intermediate Coat: Aluminum paint[, MPI #1].
   c. Topcoat: Aluminum paint[, MPI #1].

G. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Water-Based Light Industrial Coating System:

   a. Prime Coat: Primer, quick dry, for aluminum[, MPI #95].
   b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
   c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

2. Aluminum Paint System:

   a. Prime Coat: Primer, vinyl wash[, MPI #80].
   b. Intermediate Coat: Aluminum paint[, MPI #1].
   c. Topcoat: Aluminum paint[, MPI #1].

H. Wood Substrates: Including wood trim, architectural woodwork, doors, windows, wood-based panel products, glued-laminated construction, exposed joists and exposed beams.

1. Latex System:

a. Prime Coat: Primer, latex, for interior wood[, MPI #39].
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5)[, MPI #54].

2. Latex over Alkyd Primer System:

a. Prime Coat: Primer sealer, alkyd, interior[, MPI #45].
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5)[, MPI #54].

3. High-Performance Architectural Latex System:

a. Prime Coat: Primer, latex, for interior wood[, MPI #39].
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5)[, MPI #141].

I. Wood Substrates, Traffic Surfaces:

1. Latex Floor Paint System:

a. Prime Coat: Primer sealer, alkyd, interior[, MPI #45].
b. Intermediate Coat: Floor paint, latex, low gloss (maximum Gloss Level 3)[, MPI #60].
c. Topcoat: Floor paint, latex, low gloss (maximum Gloss Level 3)[, MPI #60].

2. Alkyd Floor Enamel System:

a. Prime Coat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
b. Intermediate Coat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].
c. Topcoat: Floor enamel, alkyd, gloss (Gloss Level 6)[, MPI #27].

J. Gypsum Board & Plaster Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer sealer, latex, interior[, MPI #50].
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5)[, MPI #153].

END OF SECTION 099123

SECTION 114000 - FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Documents, apply to the Work specified in this Section.

1.2 SUMMARY OF THE WORK

Project Name and Location: Sour Lake Elementary School
1055 Hwy 326 South,
Sour Lake, Texas 77659

A. Approval of Working Surface: Any contractor performing work over the work of other contractors shall notify the Architect of any unsatisfactory conditions. The beginning of work by any contractor shall constitute acceptance of the previous work.

B. Field Verification of All Dimensions: Before ordering any materials or doing any work, field verify all measurements of the building and be responsible for their accuracy. No extras will be allowed for variations from drawings in existing conditions or work performed under this contract. Any discrepancies found shall be submitted to the Architect or Foodservice Design Professionals (FDP) for instructions before proceeding.

C. Cutting and Patching: No excessive cutting will be permitted, nor shall any structural members be cut without the written approval of the Architect. Each Contractor shall leave all chases and openings straight, true, and of the proper size in their work, as may be necessary for the proper installation of their and other contractors' work. After such work has been installed, the contractor shall carefully fit around, close, repair, patch, and point up the same as directed to the satisfaction of the Architect.

D. Cooperation: The General Contractor, all other contractors, and all subcontractors shall coordinate their work with all adjacent work and shall cooperate with all other trades to facilitate the general progress of the work. Each trade shall afford all the other trades every reasonable opportunity to install their work and store their material.

E. Inspection and Tests: The architect, Owner, Foodservice Design Professionals (FDP), and their representative shall always have access to the work, whether in preparation or progress. Provide proper and safe facilities for such access and inspection.

F. Fees, Permits, and Inspections: Secure and pay fees for all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, codes, rules, regulations, and contract requirements bearing on the work.

1.3 SCOPE OF WORK

A. Include the Work specified, shown, or inferable as part of Food Service Equipment. Portions of this Work may be subcontracted to those qualified to do such work as necessary because of jurisdictional trade agreements and restrictions.

B. The General Contractor is responsible for Related Work specified in other Sections: i.e., final plumbing, electrical and mechanical connections. The Kitchen Equipment Contractor (KEC) is responsible for all internal connections.

C. Specifications and drawings have been prepared to form the basis for procurement, erection, start-up, and equipment adjustment in this contract. Plans and specifications shall be considered mutually explanatory. Work required by one, but not by the other, shall be performed as though required by both. Items required by one but not by the other shall be provided as though required by both. Work shall be accomplished as called for in specifications and shown on drawings so that all equipment items shall be entirely functional for the purpose for which they were designed and intended. Provide all necessary material, tools, equipment, and labor required for the complete delivery, un-crating, erection, and installation as designated on the food service equipment plan and, in the specifications, to be made ready for final connection by the appropriate Division contractors. When there is any discrepancy between drawings and specifications, bidders should seek clarification of any discrepancies from the Architect and or Foodservice Design Professionals (FDP) before bidding.

D. Should the drawings disagree in themselves or the specifications with the drawings *(and clarification was not sought before bidding)*, the higher cost, better quality, more stringent, and greater quantity of the work or materials shall be completed without additional costs to the Owner.

1.4 OTHER DIVISIONS/CONTRACTORS RELATED WORK

A. Division 22 (Plumbing) is responsible for but not limited to:

1. All connections shall be made in accordance with local codes and national standards, except where plans and specifications exceed those codes and standards.

2. Rough-in and final connection of plumbing systems to food service equipment and between components (including materials and labor). Accessories provided loose with food service equipment by Section 114000 to be field installed by Division 22. This includes but is not limited to the installation of all faucets (water fill faucets, pre-rinse faucets, etc.), hoses, gas disconnects and drains from the equipment point of connection to building plumbing systems. All drain lines are provided and installed by Div. 22.

    a. Kitchen Equipment Contractor is responsible for providing all faucets (water fill faucets, pre-rinse faucets, etc.), drain fittings, mixing valves, control valves, water pressure regulators, vacuum breakers, and all accessories for equipment specified under 114000. Division 22 is responsible for installation.

3. Indirect drain line runs from the equipment to the nearest drain or floor sink—lines to be type 'K' Copper.

4. If any plumbing accessories or fittings are provided loose with equipment by 114000, Div. 22 is to attach to equipment and provide final connection.

5. Water Supply Systems with all components and fittings required for a complete system.

6. Piping and Drainage Systems (Sanitary and Grease-laden). ***Systems must be cleaned and flushed before the final connection with food service equipment - Critical.***

7. Floor Sinks (Provide and Install). Flange and grates to be flush with the finished floor.

8. Floor Drains (Provide and Install). Flange and grates to be flush with the finished floor.

9. Grease Traps as required (Size, Provide, Locate, and Install). Verify with local codes to bypass or pipe through Grease Trap and/or Interceptor.

10. P-Traps as required (including all disposers).

11. Interconnect water through Water Filter (Filter provided by 114000 unless otherwise specified) to equipment.

12. Safety Restraint Cable Installation (Safety Restraint Cable Provided by 114000).

13. Specified couplings and piping to all equipment furnished by 114000.

14. Water Softeners (if required for this project) (Size, Provide, and Install unless otherwise specified).

15. Hand Sinks (Provide (unless otherwise specified) and install). Provide a hot water tempering valve if required. Water temperature to be at least 100 degrees and flow for at least 20 seconds.

16. Ice Bin Drain Insulation (if Ice Machine is provided in this project) (Provide and Install).

17. Unions at disposer solenoid valves (if Disposer is provided in this project) (Provide and Install).

18. Back Flow Prevention as required (Provide and Install - including all disposers). Back- Siphonage shall be installed at all fixtures and equipment where backflow and/or back-siphonage may occur and where a minimum air gap cannot be provided between the water to the fixture or equipment at its flood/level rim. When furnished with equipment, vacuum breakers shall override the above if acceptable with applicable codes. Division 22 is responsible for verifying requirements with local codes.

19. Exhaust Hood condensate drain connections (if Exhaust Hood is provided in this project) (Provide and Install).

20. Interconnection of ½" CW to Pre-Rinse and Disposers cone/body inlets piped through the solenoid and vacuum breaker (if Disposer is provided in this project).

21. Pipe ½" cold water to swirl inlets at disposers (if Disposer is provided in this project).

22. Refer to Section 2.2 PLUMBING / MECHANICAL REQUIREMENTS for additional information.

B. Division 23 (Mechanical) responsible for but not limited to:

1. All connections shall be made following local codes and national standards, except where plans and specifications exceed those codes and standards.

2. Rough-in and final connection of mechanical systems to food service equipment, walk-in assemblies, and between components (including materials and labor).

3. Exhaust Hoods, Condensate Hoods, Fire Suppression Systems, connections, and controls (Provide and Install – unless otherwise specified). Provide tempered air at all supply ducts.

    a. If Exhaust/Condensate Hoods and Fire Suppression Systems are specified under Section 114000, Division 23 is responsible for all Exhaust and Condensate Hood connections (Provide and Install).

4. VFD System and controllers when required by code (Provide and Install).

5. Provide and install all ventilation (direct or indirect), air conditioning, and heating systems (unless otherwise specified).

6. Refer to Section 2.2 PLUMBING / MECHANICAL REQUIREMENTS for additional information.

C. Division 26 (Electrical) responsible for but not limited to:

1. Rough-in and final connection of electrical systems to food service equipment and between components (including materials and labor). Accessories provided loose with food service equipment by Section 114000 to be field installed by Division 26.

2. Table Limit Switch Installation (Provided loose by Section 114000) (if Dishmachine is provided in this project).

3. Electrical Materials and Devices (Shunt-trip breakers, surge protectors, lighting control devices, conduit, wire, etc.).

4. Switches and Stainless Steel Disconnects as required (Provide, Locate, and Install – to be in an accessible location).

5. Interconnection between Condensate Fan and Dishmachine control panel (if equipment is provided in this project).

6. If any electrical accessories, fittings, and cord/plugs are provided loose with equipment by 114000, Div. 26 is to attach to equipment and provide final connection.

7. Provide waterproof receptacles in wet areas.

8. Receptacles will be pre-wired to Junction Box or Load Center for final connection by Division 26.

9. All electrical lighting, power, and distribution systems.

10. Do not interconnect more than three (3) convenience outlets on one (1) breaker.

11. Other than convenience outlets, all electrical connections on food service plans are dedicated breakers.

12. Electrical contractor to provide conduit with pulled wires prior to installation of equipment.

13. Refer to Section 2.5, ELECTRICAL REQUIREMENTS, for additional information.

D. General Contractor responsible for but not limited to:

1. Any wall penetration required for food service equipment utilities. Escutcheon plates or S/S sleeves are to be provided and installed as needed.

2. Furnish and Install ¾" Plywood blocking in the wall for mounting equipment furnished by Section 114000 as required.

3. Soap and towel dispenser provided by Owner. G.C. is responsible for installation.

4. Final cleaning of all equipment before demonstrations.

1.5 QUALITY ASSURANCE

A. In addition to complying with all applicable laws, statutes, building codes, and regulations of public authorities, comply with the following:

1. National Sanitation Foundation (all equipment to bear label)

2. National Electric Code

3. Underwriters' Laboratories, Inc. (all applicable equipment to bear label)

4. American Gas Association Laboratories

5. National Fire Protection Association

6. Americans with Disabilities Act

7. Food and Drug Administration HAACP Guidelines

8. International Energy Conservation Code (IECC)

9. Department of Energy

10.Environmental Protection Agency

11.CSA Group

B. Furnish certification of regularly manufactured equipment listing or classification by Underwriter's Laboratories, Inc. with the initial submittal.

C. Furnish a list of equipment and components (internal and external) that are not of domestic origin. All equipment and components (internal and external) should be of domestic origin when possible. This information should be provided with the initial submittal.

D. Projects outside the continental United States shall adhere to all local authorities having jurisdiction over that project.

1.6 SUBSTITUTIONS

A. **The specified equipment items or components are intended to be the basis of the bid. All other brands, including any additional names, which may be listed as "Alternates" or "Approved Equal," must conform with the general and item specifications, warranties, size/dimensions, quality, accessories, function, voltage, horsepower, etc. of the first-named brand and be subject to Paragraph C-03 of this Article.**

B. Proposed Substitutions:

1. Submitted at least 14 calendar days before Bid Date.

2. Submit proposed substitutions with catalog data and manufacturer's shop details indicating all modifications required to conform with the specified brand.

3. List of deviations must include equipment name, model number, accessories, and features with deviation(s) noted for specified and proposed alternate equipment. Equipment without listed deviation(s) will be considered furnished as specified.

C. Substitutions with prior approval:

1. Submitted on Bidder's letterhead attached to Proposal Form with individual additive/deductive amounts stipulated and the documentation required in Paragraph B-02.

2. Owner reserves the right to accept or reject any or all substitution proposals before execution of the Contract.

3. Provide all design/engineering services required to adjust in space, systems, utilities, etc., and pay all additional costs of utilities, construction, or professional services that may be incurred due to the acceptance of any substitution.

D. All appliances or other equipment within a common group or category (e.g., refrigerators, kettles, ovens, shelving, etc.) must be from the same manufacturer.

1.7 INTERPRETATION OF DOCUMENTS

A. During Bidding: Bidder's, supplier's, or vendor's questions and comments about Construction Document's clarity or intent will be addressed by addendum.

B. After Award:

1. Clarification Bulletin will confirm Construction Document requirements.

2. Request for Information submitted by Contractor shall contain Contractor's proposed resolution.

1.8 WARRANTY

A. Provide a written warranty for parts and labor for one year ***from the date of Substantial Completion***, including an extended four-year replacement warranty on compressor bodies.

B. Components of equipment subject to replacement before one year's use (such as refrigerator door gaskets) and those items which may fail due to improper or inadequate periodic maintenance by the Owner/Operator (such as an uncleaned refrigeration system condenser) are not intended to be included within the scope of the Warranty.

C. Furnish three copies of a list of all equipment and their respective local service agencies, indicating the address, telephone number, and name of the person to contact. The service agencies selected shall be factory-authorized for the equipment assigned whenever possible.

D. ***All above-stated warranty periods are from the date of Substantial Completion***. All replacement parts due to a warranty call should be the same quality as the original, or better if the original were defective. Replacement parts should be of a domestic origin where possible.

1.9 SUBMITTAL DATA

A. **All submittals must be received, reviewed, and approved as noted prior to equipment procurement. If any equipment is procured prior to this process, it is on the KEC to replace any equipment, accessories, or other components that may not meet the specifications or design intent for the facility, including all costs associated with rectifying the errors made procuring the equipment before this critical process.**

B. Special Requirements: The following are in addition to any general requirements given elsewhere in the Documents.

C. Submittal Requirements:

1. Kitchen Equipment Contractor to furnish all submittals via PDF, drawings to be scaled per General Specifications and provided in Three (3) submittal packages.

2. Foodservice Design Professionals requires the below-listed business days for each package submitted. Packages are to be submitted within 14 days between each issued package. Each package should contain individual submittal sets.

    a. Package One to include (2) Individual sets: 10 Business Days for Review

        i. Equipment rough-in

        ii. Equipment Brochure

    b. Package Two to include (2) Individual set: 10 Business Days for Review

        i. Exhaust Hoods

    c. Package Three to include (2) Individual sets: 15 Business Days for Review

        i. Custom Fabrication

        ii. Miscellaneous Submittals

D. Submittals to be identified with the below-listed file name structure:

1. 114000-1 EQUIPMENT BROCHURE

2. 114000-2 EQUIPMENT ROUGH-IN PLANS

3. 114000-3 CUSTOM FABRICATION

4. 114000-5 EXHAUST HOODS

E. Package One (1) requires both submittals: Brochure and Rough-in plans. **If not sent together, the submittal will be rejected.**

F. Foodservice Design Professionals (FDP) will notate all submittals in RED. Architects and General contractors will be notated in color per their direction.

G. If hard copy submittals are required, Kitchen Equipment Contractor will furnish all copies to the specified trades as required.

H. If discrepancies, missing information, or incorrect information occur within the documents, Kitchen Equipment Contractor is to seek clarification or note the need for further direction on submittals. The Kitchen Equipment Contractor is to bid the higher of the discrepancies. *Refer to Section 1.3 SCOPE OF WORK: Subsection D.*

I. Brochure Format (for regularly manufactured equipment and components):

1. Front and rear protective cover with labeled project name.

2. Brochure index: Indicate Functional Area/Room number, item number, quantity, description, and manufacturer.

3. A separate flysheet for each component or item of equipment, indicating item number, name, quantity, manufacturer, optional equipment, modifications,

special instructions, and utility requirements. Any equipment or assembly containing more than one buyout sub-assembly or component shall have the second item listed in parenthesis beside the primary item name—for example, Serving Counter (hot food well).

4. Catalog specification sheet with all options notated on the specification sheet and manufacturer's drawing.

J. Shop Drawings (Rough-In Drawings):

1. Separate drawing sheets: same size as Contract Drawings (Contract Drawings are not to be traced or reproduced). Submittal drawings are to be provided by Kitchen Equipment Contractor and not copied or reproduced from Contract Documents. Any reproduced submittal drawings will be rejected.

2. ¼" scale drawing of fixed/movable food service equipment and prefabricated Walk-in assemblies with itemized schedules.

3. Special Conditions Drawings, sizing, and locating the following conditions:

   a. Slab depressions, cores, sleeves, or block-outs (drain trenches, piping, etc.).

   b. Concrete or masonry platforms.

   c. Pipe sleeves or roof jacks.

   d. Wall openings or block-outs for pass-through equipment, recessed control panels, in-wall fire-protection system components, etc.

   e. Blocking grounds or anchor plates required in walls for equipment support/attachment.

   f. Above-ceiling hanger assemblies for support of exhaust hoods, ceiling-mounted pot racks, etc.

   g. Access panels in walls or ceiling for service of equipment.

   h. Ceiling pockets or recesses for unusually high equipment.

   i. In-wall carriers for wall-hung or cantilevered equipment.

4. Electrical Rough-In Drawing

5. Plumbing and Mechanical Rough-In Drawing

6. Required information:

   a. All fixed and portable food service equipment shown on Contract Drawings.

b. All prefabricated Conveyor/Dishtable Assemblies shown on Contract Drawings.

c. All general-use and convenience utilities or services indicated on Contract Drawings, including those required by or connected to equipment or devices, not in this Section.

d. All Rough-In Drawings: Fully dimensioned from engineering benchmark (column lines, when provided) and finished-room surface to the point of stub-up through floor and stub-out through wall or ceiling for all mechanical, electrical, and plumbing services.

e. Connection number/tag system and symbols: Identical to Contract Drawings.

K. Shop Drawings (Manufacturer's and Fabricator's):

1. Sheet Size: Identical to Contract Drawings, drawn or plotted at a ¼" scale for plan view, ½" for elevations, and 1½" for sections and construction details.

2. Included information: The item number, name, and quantity.

3. Construction details, sections, and elevations to reflect the requirements of the Specifications and Drawings.

4. Indicate adjacent walls, columns, and equipment.

5. Indicate plumbing and electrical schematic drawings for equipment such as conveyors, waste systems, self-cleaning exhaust hoods, exhaust hood fire protection systems, and fabricated fixtures with a single electrical or plumbing connection.

6. Mechanical or electrical operating components or products integrated into a fabricated fixture: ventilation and service access required or recommended by the manufacturer, including panel size and location to permit easy lubrication, adjustment, or replacement of all moving parts.

L. All equipment and engineering rough-in plans sheet numbers are to match the contract documents. All equipment item numbers, and engineer item numbers located on the schedules are to match the contract documents. All engineering requirements must be updated to accommodate the provided equipment and match the contract documents. The Kitchen Contractor coordinates any MEP revisions to accommodate the supplied and proposed equipment. The Kitchen Equipment Contractor is responsible for any costs associated with equipment substitution.

M. Foodservice Design Professionals (FDP) drawings and schedules are not to be copied in any way. Any replicated drawings of Foodservice Design Professionals (FDP) will be rejected.

1.10 SERVICE MANUAL

A. Three copies bound in 1½" hardback, three-ring binders (as many volumes as required by the scope of the project) with the same data as the brochure after

installation (Refer to “Submittal Data”). Provide separate service manuals for each independent area within the project scope (Main Kitchen, Culinary, Concession, etc.).

B. Each Volume: Section for maintenance of finish materials (e.g., stainless steel, plastic laminates, FRP, Plexiglas, etc.).

C. Catalog specification sheet and/or manufacturer’s shop drawings.

D. Each Volume: Index of items, manufacturer’s operating/maintenance information, replacement parts data, list of all product warranties, and price lists. Provide the name, title, and address of personnel at each respective manufacturer and service personnel to be contacted for spare/replacement parts and service after the warranty period.

E. To the greatest extent possible, provide two copies of the manufacturer’s instructional video cassettes for operating, maintenance, and equipment service.

F. Internally subdivide binder contents with permanent page dividers, logically organized by equipment item number or manufacturer name, with tab titling printed under reinforced, laminated plastic tabs.

G. Electronically submitted manuals must follow the formatting requirements listed above.

H. **Service Manual to be provided to the owner before kitchen equipment demonstration.**

1.11 VERIFICATION AND COORDINATION OF PROJECT / DATA

A. Utilities Rough-in Drawings and field verifications are to be completed within four weeks after receipt of notice-to-proceed. Review Contract Drawings and Submittal Data for accuracy and completeness and notify Architect of conflicts and proposed adjustments. Coordinate work with other sub-contractors.

1. KEC to provide on-site field verification of all underground utilities before pouring concrete for capacity and location and coordinate with General Contractor. Submit a review to Architect and General Contractor. If rough-ins need to be relocated, KEC will compensate other trades for the required relocation.

2. KEC to provide on-site field verification of all other utility connections and locations and coordinate with General Contractor. Submit a review to Architect and General Contractor.

B. On-Site Inspection Reports

1. Before concrete pour: The Kitchen Equipment Contractor is to submit a copy of the report below to the Architect, General Contractor, and Foodservice Design Professionals (FDP) within 24 hours of the inspection. The form to be submitted is contained within these General Specifications.

2. Before delivery of equipment: The Kitchen Equipment Contractor is to submit a copy of the report below to the Architect, General Contractor, and Foodservice Design Professionals (FDP) within 24 hours of the inspection. The form to be submitted is contained within these General Specifications.

FOODSERVICE DESIGN PROFESSIONALS

0n - Site Inspection Report

Prior to Delivery of Equipment

Inspection Date_____ **Project Name** _____

Project Location_____

Inspector's Name_____ **Company** _____

Inspector's Contact Number_____ **Email** _____

Architectural Firm_____ **Project Architect** _____

Architect's Contact Number_____ **Email** _____

General Contractor_____ **Project Manager** _____

G.C. Contact Number_____ **Email** _____

Food Service Consultant Foodservice Design Professionals, LLC **Project Manager**_____

Contact Number 281.350.2323 **Email** _____

An on-site Inspection to verify the location of INSTALLED utilities was conducted on this date. The following conditions were observed and brought to the attention of the General Contractor. (KEC is to provide a written description and copy of the Utility Plan indicating the corrective action required).

1. What difficulties were encountered?

Inspector's Initials _____

This Inspection Report is the responsibility of the Kitchen Equipment Supplier and the General Contractor. Coordination between the two parties is mandatory.
Neither the Architect nor FDP need to be present at these inspections.

EMAIL A COPY OF THIS REPORT AND ANY ADDITIONAL INFORMATION TO THE ARCHITECT, GENERAL CONTRACTOR AND FOODSERVICE DESIGN PROFESSIONALS, LLC.

C. Review critical systems/components for application, performance, and capacity and submit calculation worksheets with the initial submission of brochure/rough-in drawings, with all proposed adjustments noted, including:

1. Exhaust hood removal/supply air volume, velocity, static pressure, duct collar sizes, and locations.

2. Exhaust Hood Fire Suppression Systems (nozzle locations, air handler, fuel interlocks, piping/distance limitations).

3. Locations of Vacuum Breakers.

4. Water line sizes and manifold configurations.

5. ADA compliance of workstations, service positions, passageways, etc.

D. Ceiling mounted appliances/fixtures: Verify and coordinate dimensions/location of support framing/hangers with the General Contractor—all material and installation below 12’-0” AFF: Section 114000.

E. Dimension Responsibility: Obtain actual or guaranteed measurements for the proper equipment fit. All dimensions indicated in Contract Documents are approximate and are as accurate as can be determined at the time. Field-check all horizontal/vertical measurements and conditions at the building before fabrication or delivery of equipment and notify the Architect of all conflicts or deviations from the dimensions shown.

F. Checking Dimensions at Site: Before ordering any materials or doing any work, verify all measurements of the building and be responsible for their correctness. No extras will be allowed for variations from drawings in existing conditions or work performed under this contract. Any discrepancies found shall be submitted to the Architect for instructions before proceeding.

G. Scheduling to Fit Openings: Should it become necessary to schedule the construction of walls or partitions before delivery of fixed equipment, the equipment must be fabricated for passage through finished openings. Maintain close contact with the project and be cognizant of all conditions, including vertical handling limitations within the building (elevator cabs or openings, stairs, etc.) and possible hoisting requirements. Coordinate all procedures with General Contractor and Project Team.

H. Dry Storage Areas: Verify and coordinate dimensions to accommodate scheduled modular shelf sections. Notify Architect of the variance between the Contract Documents and actual conditions.

I. Color/Pattern Selections: Submit selection samples of solid polymer products, plastic laminate, paint or stain finishes, and vinyl-coated surface material of equipment as selected by the Owner.

J. Movable Equipment Interface: Rolling stock (pan racks, carts, dollies, dish/tray/rack dispensers) required to fit through or into fixed equipment (roll-in refrigerators, counter bodies, etc.) is to be reviewed and coordinated for compatibility at the time initial of shop drawing submittal. Indicate conflicts and proposed adjustments.

K. Relocation of Work: Relocate or re-route work as required to coordinate related items free of charge if no extra work is involved.

L. **Kitchen Equipment Contractor must provide FDP with the food service equipment lump sum pricing (including material and labor) after the contract has been executed and *before submittals* are provided to FDP. *This information is critical to FDP for accounting/billing purposes.***

1.12 EQUIPMENT FURNISHED / INSTALLED BY OTHERS

A. Obtain and coordinate utility requirements of Owner-Furnished/Owner-Installed (OF/OI) equipment with the building utilities and rough-in drawings/provisions.

B. Coordinate physical data of OF/OI appliances or equipment and incorporate information into Submittal Drawings. Vendor- or Purveyor-Furnished equipment (e.g., coffee/tea equipment): same as OF/OI.

1.13 WORK INSTALLED BUT FURNISHED BY OTHERS

A. Coordinate delivery/installation schedule of Owner-Furnished/Contractor-Installed (OF/CI) equipment with the Owner at least ninety (90) days before equipment requirement.

B. Obtain and coordinate utility requirements of OF/CI equipment with the building utilities and rough-in drawings/provisions.

C. Receive at the job site and fully incorporate into installation procedures as if furnished under this Section.

PART 2 - PRODUCTS

2.1 FABRICATED FIXTURES MATERIAL / COMPONENTS

A. Stainless steel sheets or shapes: 18-8, Type 302, polished to 180 grit No. 4 finish.

1. Stainless steel joints and seams: Heli-arc welded, free of pits and flaws, ground smooth, and polished to a No. 4 finish.

2. The “grain” direction of horizontal stainless-steel surfaces: Longitudinal, including the backsplash. The polishing procedure at right-angle corners of fixtures shall provide a mitered appearance.

B. Galvanized Iron Sheets: Armco copper bearing Zinc Grip or Zinc Grip/Paint Grip.

1. Galvanized iron joints and seams: Arc-welded, free of pits, flaws, and ground smooth.

2. Galvanized sheets or shapes: Washed with mineral spirits and painted with Rust-Oleum gray semi-gloss enamel.

C. Sound Deadening: Schnee Butyl Sealant ½" wide rope positioned continuously between all frame members or contact material and underside of stainless-steel surface (sinks, tabletops, food wells, over shelves, and undershelves). Tighten stud bolts for maximum compression of sealant and trim excess.

D. Plastic Laminates: Color/pattern selected by Architect, in 1/16" thickness for flat surfaces: 1/32" thickness for radiused surfaces. Plastic laminates and adhesives must be NSF-approved (Standard No. 35).

E. Solid Polymer products: Color/pattern/material selected by Architect in thickness as specified. Solid Polymers and adhesives must be N.S.F. approved (Standard No. 51).

F. Casters:

1. Fabricated fixtures with "Open Base" construction: Jarvis and Jarvis Model No. 5-405-113P-NSF swivel casters with grease seals on forks and wheels; Zerk fitting in swivel; two casters: Model No. E-75 Verti-Lock brakes. All casters: B-7" rolling bumpers with stainless steel top discs.

G. Identification Plates, Labels, Tags:

1. Prohibited Information: Names of suppliers, fabricators, and contractors.

2. NSF Labels: Required on all pieces of equipment.

3. Required Information: Function or purpose of controls such as display light switches, food warmer controls, etc.

4. Plate Construction: Engraved phenolic plastic, secured to equipment with epoxy cement or stainless-steel screws. Furnish samples.

2.2 PLUMBING / MECHANICAL REQUIREMENTS

A. Plumbing Fittings and Components: Furnished under this Section as follows:

Note: Fitting and components described in Items 1, 2, 3, 4, and 5 are furnished loose by 114000 for final installation and connection by Division 22.

1. Control valves and appliance pressure regulators for water, gas, steam, and vacuum breakers: wherever required on food service equipment (chrome-plated where exposed).

2. Faucets and drains with and without connected overflows (unless otherwise indicated) for all sinks.

3. Specialty food service water-fill faucets, hose bibbs, or hose assemblies indicated in drawings/specifications.

4. Wade Model No. W-10 Shock-Stop shock absorbers for all food service equipment with quick-opening or solenoid-operated water valves.

5. Dormont Series Water Quick Disconnect hose, diameter per water connection size requirements, with safety fitting, w/coiled restraining device, full port ball valve, antimicrobial coating, lifetime warranty.

6. Extensions of indirect waste fittings to open-sight floor sink or floor drains from sinks, under bar equipment, and food-holding components of serving counters (e.g., cold pans, hot food wells, refrigerator/freezer coils not equipped with condensate evaporators) furnished and installed by Division 22. Drains: All drains to be type 'K' Copper – Paint with aluminum paint where exposed**. Div. 22 to ensure a minimum air gap of 1" and not less than twice the effective opening of the indirect waste pipe, per code. Div. 22 to ensure all drain lines are centered over floor sink grate openings and no water splashes on the floor.**

7. Piping brackets and supports beneath fabricated equipment.

8. Closed Base Bodies: Removable 18-gauge stainless steel closure panel at plumbing penetrations under the top.

9. Control valves on Open Base fixtures: Mounted on a 14-gauge stainless steel gusset-shaped panel with h 3½" setback from the countertop edge/rim to the face of the control handle.

10. Fill hose/faucet at support pedestals or Closed Base Body: Installed in a 15" x 18" x 5" deep recessed mounting panel. Panel bottom: sloped on a 60° angle, with 3/8" stainless steel rod hanger-bracket for the hose.

11. Provide filtration option as shown on contract documents (a, b, c, or combination thereof):

    a. In-line Water Filter System:

        i. Everpure System filters for coffee/tea brewers, icemakers, water chillers, convection steamers, and beverage systems. They should be sized per the manufacturer's recommendation.

    b. Remote Central Water Filter System.

    c. Remote and/or In-line Reverse Osmosis system.

B. Final Plumbing Connections Provisions:

1. Fabricated equipment containing components, fittings, and devices indicated on food service connection drawings to be connected to the building systems: each component, fitting, or group thereof pre-piped to a utility compartment for final connection by Division 22. Refer to drawings for capacities.

2. Field-assembled equipment (e.g., prefabricated walk-in assemblies, exhaust hoods, ware wash machines, convection ovens, etc.): plumbing components completely interconnected under this Section for final connection arrangements indicated on Utility Connection Drawings.

3. All plumbing final connection points of equipment shall be tagged, indicating the following:

    a. Item number

    b. Name of devices or components

    c. Type of utility (water, gas, steam, drain, chilled water)

C. Ducts and Vents:

1. Exhaust hoods furred-in to ceiling: 2” high duct collar for final connection to the duct system.

2. Warewash machines equipped with integral vent cowls or extended hoods: furnished with 18-gauge stainless steel seamless duct risers to 6” above the finished ceiling for final connection. The duct: trimmed at the ceiling with a 16-gauge stainless steel angle flange with all corners welded.

D. Refer to Section 1.4: OTHER DIVISIONS/CONTRACTORS RELATED WORK; Sub Sections E. Plumbing and F. Mechanical for additional information.

2.3 PLUMBING TRIM

A. Faucets: Furnished for all sinks or equipment requiring open water supply.

B. Fill Faucets: Furnished for appliances requiring open water supply.

C. Drain Fittings: Furnished for all sinks or equipment requiring removal of liquids. Install specified chrome-plated or stainless-steel fittings in die-stamped openings with washers and locknuts. The solder may be used as a sealer but shall not be applied to the top surface of the drain fittings.

2.4 ELECTRICAL REQUIREMENTS

A. All electrical systems, components, and accessories within the work of this Section: Certified to be in accordance with NEC 70.

B. Electrical Fittings and Components: Furnished under this Section as follows. Coordinate food service equipment loads, voltage, and phase with the building system and confirm any existing or OF/OI equipment requirements.

C. Cord and Caps:

1. Coordinate all food service equipment cord/caps with related receptacles.

2. All 120, 120/208, and 208 volts “plug-in” equipment shall have Type SO or SJO cord and plug with ground wire fastened to the frame/body of the item.

3. Cord lengths for fixed equipment: Adjusted to eliminate loose-hanging excess.

4. All non-fixed plug-in “buy-out” equipment: Hubbell configuration and ratings as required.

5. All mobile electrical support equipment (heated cabinets, dish carts, etc.) and counter appliances mounted on mobile stands (mixers, food cutters, toasters, coffee makers, microwave ovens, etc.): 8'-0" cord length with cord-hanger strap secured to the rear of equipment or mobile stand.

D. Switches and Controls:

1. Each motor-driven appliance or electrically heated unit: Equipped with a control switch or starter per Underwriters' Laboratories, Inc., with low-voltage and overload protection.

2. Disposer controls recess-mounted in the wall: External fittings and accessories removed from the enclosure and furnished with 16-gauge stainless steel perimeter angle flange with welded corners. Install control at 4'-0" AFF to the bottom of the enclosure.

3. Disposer controls recess-mounted in counter-splash risers: External fittings and accessories removed from NEMA 4 enclosure and furnished with 16-gauge stainless steel perimeter angle flange with welded corners. Install control at 3'-0" AFF to the bottom of the enclosure. Provide the panel with a 60" long Seal-Tite electrical conduit from the bottom of the control panel for final field connections under Division 26.

4. Equipment that is not provided with built-in circuit breakers or fused terminal block and is indicated on Utility Connections Drawings to be directly connected to the building electrical system: a NEMA 4 stainless steel disconnect switch furnished and installed by Division 26.

5. All remote manual starters, disconnect switches, magnetic contactors or starters, and push-button stations: NEMA Type 4 enclosure; NEMA Type 1 enclosure only when installed in a Closed Base Body.

E. Heating Elements:

1. Electrically heated equipment: Thermostatic controls.

2. Water heating equipment: Equipped with positive low water shut-off.

F. Receptacles and Switches:

1. Receptacles installed in vertical panels of support pedestals or Closed Base Bodies: installed in 12" x 8½" x 3" deep recessed mounting panel sloped at a 60° angle and turned up to the top of the opening.

2. Pre-wire receptacles in closed base fixtures to a junction box installed within 6" from the bottom of utility or compressor compartments.

3. Receptacles mounted on Open Base fixtures: Installed on a 12" x 10½" x 4½" deep 14-gauge stainless steel panel with returned ends and sloping recess—secure panel to the underframe of fixture top.

4. Pre-wire receptacles on open base fixtures to a junction box secured to a leg or mounted on the underside of the lower shelf. Vertical runs of wiring: Made in rigid conduit or within the tubular leg.

5. Receptacles installed in/on-fabricated equipment: Hubbell, Inc. assemblies horizontally mounted in a metal box with stainless steel cover plate.

6. Switches installed in/on-fabricated equipment: Hubbell, Inc. with metal box and stainless-steel cover plate. Switches: pre-wired to the controlled device and a junction box installed within 6" from the bottom of the utility or compressor compartment. All refrigeration system switches: Installed within the compressor compartment near the door opening.

G. Final Electrical Connection Provisions:

1. Fabricated equipment containing electrically operated components or fittings indicated on Utility Connections Drawings: Direct connected, with each component, fitting, or group pre-wired to a junction box for final connection by Division 26. Refer to drawings for circuit loading.

2. Fabricated equipment containing electrically operated components and devices indicated: Circuit-breaker load center with each component or device pre-wired to a separate circuit breaker for balanced phase loading and single final connection by Division 26.

3. Field-assembled equipment (e.g., exhaust hoods, ware wash machines, etc.) shall have electrical components completely interconnected in this Section for final connection arrangements as indicated on Utility Connection Drawings by Division 26.

4. All electrical final connection points of equipment shall be tagged, indicating the following:

   a. Item number.

   b. Name of devices on the circuit.

   c. Total electrical load.

   d. Voltage and phase.

H. Refer to Section 1.4: OTHER DIVISIONS/CONTRACTORS RELATED WORK; Subsection F. Division 26 (Electrical) for additional information.

2.5 CUSTOM – FABRICATED / ASSEMBLED UNITS

A. Mechanical or electrical operating components or products integrated into a fabricated fixture: Ventilation and service access required or recommended by the manufacturer. The size and placement of the service access panel(s) permit easy lubrication, adjustment, or replacement of all moving parts and are to be indicated on fabrication shop drawings.

2.6 TABLETOPS

A. 14-gauge stainless steel; all free edges turned down 2” with ¾” tight hem at the bottom—free corners: rounded on ¾” radius.

B. Marine edges: Turned up ½” on 45º angle and turned down 2” with ¾” tight hem at the bottom.

C. Tops abutting high fixtures or walls: Cove up specified height and slope back 1½” at the top on 45º angle; 2½” slope where piping occurs. Turn down 1” at the rear of the splash and tight ends to the bottom of the top turndown. Secure splash turndown to the wall with a 4” long 14-gauge stainless steel “Z” clip anchored to the wall, 36” OC.

D. Freestanding tables: Turned back at a 90º angle with 1” turndown at the rear.

E. Brace tops with rigid-welded 1½” x 1½” x 1/8” galvanized steel angle frame at the perimeter with cross bracing 2’-0” OC maximum. Provide 4” x 4” x 12-gauge stainless steel triangular pads where leg gusset welds to frame. Paint the entire frame with Rust-Oleum gray semi-gloss enamel. Angle frames: Secured to the underside of top surfaces with ¼” studs welded 9” OC maximum with chrome-plated washer, lock washer, and cap nut. Studs: Such length that cap nuts can be made up tight, bringing the top down snugly on the angle frame, eliminating all vibrations or “oil-canning.”

F. Tops: 1½” overhang at free sides of underframe or Closed Base Body.

G. Mockett Model No. SG5-26 chrome-plated/plastic grommet assembly or integrally welded stainless-steel flange or inverted gusset where service utilities or support posts penetrate or abut tops, ground, and polished to match the top. When conditions permit, provide a 1” x 1½” rectangular backsplash opening for service utilities instead of piercing the horizontal surface. Install stainless steel split tubing at the raw edge of the opening.

H. Extend underbracing members to the wall, turn down 6”, and anchor to the wall when specified to be mounted on leg/bracket assembly.

I. All openings in tops: 3/16” high raised die-formed edges.

J. All top openings for pans or inserts: 20-gauge stainless steel, watertight liners, 8½” deep, secured to the underside of the countertop.

K. Scrap Basket: 18-gauge stainless steel construction 6½” x 6½” x 21¾” long. Top of container: 5/8” wide x ¼” high full perimeter flange with ¼” diameter stainless steel rod bail handle. Interior vertical corners coved on ½” radius. Countertop: Fitted with 6¾” square die-stamped opening.

2.7 DRAWERS

A. Stainless Steel Liners: Component Hardware Model No. S81-2020C (20” x 20”), easily removable with drawer in the fully extended position.

B. Drawer Frame: 16-gauge stainless steel flanged out at the top. Weld the frame to a double-panel 16-gauge stainless steel drawer front with full-length recessed pull at the top (similar profile as Garcy Model No. R-1060) with closed ends.

C. Channel-formed horizontal pull: ¾" turndown at the front and ends with ½" tight hem. The front edge of the pull: flush with the face of the drawer. Recess behind pull: sloped up on a 60° angle, terminating 1" below the bottom edge of pull.

D. Mount drawer frame on Component Hardware Model No. S52-2020 self-closing slides, with Delrin bearings, full-depth of the fixture. Secure slides to the body or brackets to eliminate lateral movement in the extended position. Refrigerator drawers: Component Hardware Model No. S52-2024 stainless steel slides with Delrin bearings.

E. Drawer enclosure in an Open Base Fixture: 18-gauge stainless steel flanged out at the top for attachment to the underside of the tabletop. The lower edge of the enclosure is flanged in toward the open bottom. Mount drawer slides to enclosure and brace as required. The face of the enclosure is to be the same length and height of the drawer face. Provide ¾" deep offset in front of the enclosure and 2½" from the underside of the tabletop for a flush-fitting appearance.

F. Drawer enclosure on freestanding fixture: Full depth of table framing.

G. Drawer enclosure in a Closed Base Fixture: Completely partitioned from the adjoining area. Drawer front: Flush fitting with the face of the body.

H. Drawer Liners other than tool/utility: **Bread Drawer:** S/S liner sized to fit drawer;

2.8 SINKS

A. 14-gauge stainless steel; all interior corners (horizontal/vertical) coved on ¾" radius. 1½" wide double-walled partitions with flat tops between compartments.

B. Continuous exterior panels of multiple-compartment sinks: 14-gauge stainless steel filler panel welded ground and polished between compartments.

C. Sinks (with overflow): Score and slope sink bottom ½" to die-stamped opening fitted with Fisher 22306 twist waste valve 3 1/2" x 2" with overflow and tailpiece. 14-gauge stainless steel bracket: Welded to sink bottom for drain stem with 1½" handle clearance.

D. Where sinks are installed in fixtures with Closed Base Body, provide a Fisher 22306 twist waste valve 3 1/2" x 2" with overflow and tailpiece. (Sinks with dimensions larger than 20" x 20" in Closed Base Body will not have overflow fitting.) 14-gauge stainless steel bracket: welded to sink bottom with T & S Model No. BL-4740-1 guide bushing. Install on shortened drain stem, one T & S Model No. BL-4710-1 remote control stem assembly only (length as required) with Model No. 113-L universal joint and white blank button. Set drain control handle in Cambro Model PSB-6 bowl with bottom omitted (dress raw edge) to permit passage of drain handle—secure bowl in utility compartment door or body panel with clear silicone.

E. When single-hole deck-mounted faucets are specified, install overflow fitting in the sidewall of the sink compartment and provide ell-fitting in connecting tubing.

F. Flush Covers when specified: 1/2" thick Read Products, Inc. "Richlite" cutting board, size as indicated. Support clips: ¼" stainless steel rod 2" long, formed at 45º with two ¾" leg ends (¼" long threaded ends). Insert rod clips through tight-clearance holes in the sink, seal watertight, and secure with stainless steel acorn nuts or tack-weld at the exterior of the sink wall. Set support clips ½" below the top. Provide a 14-gauge stainless steel channel or angle support frame to store covers when not in use. Cover holder: Adjacent to sink compartment, below countertop, or under drawer assembly.

2.9 DISHTABLES

A. Soiled/clean dishtable: 14-gauge stainless steel; free edges coved up 3" with 1½" diameter rolled rim and bullnose corners.

B. Edge of dishtables next to high fixtures or walls: Coved up 10" and sloped back 1½" on 45º angle; 2½" slope where piping occurs. Turn down 1" at the rear of splash and secure to wall with 4" long 14-gauge stainless steel "Z" clips anchored to the wall, @ 36" OC.

C. Exposed rear splash: 16-gauge stainless steel finish panel from the top of the splash to the bottom edge of the rolled rim with a welded vertical joint at the end. Secure the panel with concealed attachment and install bracing 24" OC.

D. Cove all interior corners (horizontal/vertical) on ¾" radius and slope tables 1/8" per foot to sinks, scuppers, or ware wash machines, maintaining level crown/splash.

E. Brace dishtables with 1" x 4" 12-gauge stainless steel channels down the top centerline and between each pair of legs, with closed ends. Bracing: secured to the underside of the dishtable with ¼" studs welded 6" OC maximum, with chrome-plated washer, lock washer, and cap nut. Studs: such length that the cap nuts can be made up tight, bringing the dishtable down on the channel members, eliminating all vibration and "oil-canning."

F. Integrally welded stainless steel flange or inverted gusset where service utilities or support posts penetrate or abut tops; ground and polished to match the top.

G. Hose Bibb: Chicago Model No. 305VBRCF; mounted on 12-gauge stainless steel flange or inverted gusset bracket with 3/8" stainless steel rod hose hanger.

H. Extend underbracing members to the wall, turn down 6", and anchor to the wall when specified to be mounted on leg/bracket assembly.

I. Paper-Drop Opening: 9" square with 4" integral chute having hemmed bottom edge. Slope dishtable top 1" toward the opening, forming a 16" square tapered deposit point.

J. Accessible Tray-Drop Opening: 10" x 18" with integral 16-gauge stainless steel seamless chute sloped at 45º angle toward the center of mobile soak sink position.

K. All dishtables with a Conveyor Type Dishmachine must have a table limit switch provided by Manufacturer and installed by Division 26. Wiring must be concealed within dishtable fabrication.

2.10 DISH / TRAY DEPOSIT ASSEMBLY

A. 14-gauge stainless steel deposit shelf, size as indicated. Extend the frame through the opening, flush with the public side of the partition, height as local code authorities require. Turn the shelf down 1" at the front with ¾" return at the bottom (either scribed into a partition or forming reveal).

Shelf: 1" square turndown at the long rear side, integral with conveyor slider pan, tray-accumulator, or dishtable. Extend the rear/end splash to align with the head of the deposit station opening. Modify rolled rim at the operator's side of the tray drop window to have a 3" rolled rim.

B. 18-gauge stainless steel window frame with perimeter flange channel-formed 1" x ¾" at both wall sides. Weld all corners of the frame and install with concealed attachment. Align/abut one jamb of the frame with end splash of conveyor slider pan or dishtable whenever adjacent.

2.11 UTENSIL – WASH COUNTERS

A. 14-gauge stainless steel; all free edges coved up 3" with 1½" diameter rolled rim and bullnose corners.

B. Edges of utensil-wash counters next to high fixtures or walls: Coved up 10" and sloped back 1½" on 45º angle; 2½" slope where piping occurs. Turn down 1" at the rear of splash and secure backsplash to the wall with 4" long 14-gauge stainless steel "Z" clip anchored to wall @ 36" OC. Vacuum breaker pockets: 4" long square turnback sections aligned with the slope break line.

C. Exposed Rear Splash: 16-gauge stainless steel finished panel from the top of the splash to the bottom edge of the rolled rim with a welded vertical joint at the end of the splash and ½" turnback at the bottom of the panel. Secure the panel with concealed attachment and install bracing 24" OC.

D. Cove all interior corners (horizontal/vertical) on ¾" radius and slope tables 1/8" per foot, maintaining level crown.

E. Brace utensil-wash counters with 1" x 4" 12-gauge stainless steel channels down the centerline of the top and between each pair of legs, with closed ends. Bracing: Secured to underside of dishtable with ¼" studs welded 6" OC. maximum, with a chrome-plated washer, lock washer, and cap nut. Studs: Such length that the cap nuts can be made up tight, bringing the dishtable down on the channel members, eliminating all vibration and "oil-canning."

F. Integrally welded stainless steel flange or inverted gusset where service utilities or support posts penetrate or abut tops: ground and polished to match the top.

G. Extend underbracing members to the wall, turn down 6”, and anchor to the wall when specified to be mounted on a leg/bracket assembly.

H. Hose Bibb: Chicago Model No. 305VBRCF; mounted on 12-gauge stainless steel flange or inverted gusset bracket with 3/8” stainless steel rod hose hanger.

2.12 UTENSIL RACKS

A. Rack: ¼” x 2” 300 series stainless steel flat bar with No. 4 finish, fully welded and formed to match the shape shown on drawings. Lowest band - 7’-6” AFF unless otherwise indicated.

B. Ceiling Mount Supports 1-5/8” diameter 16-gauge stainless steel tubing from band to 18” above the ceiling. Anti-sway bracing above the ceiling - 1½” Unistrut members. Tubing penetrations at the ceiling - Component Hardware Model No. A16-0206 stainless steel gussets.

C. Table Mount Supports 1-5/8” diameter 16-gauge stainless steel tubing extended through countertop. Secure to closed base framing or cross rail/undershelf on the open base fixture. Tubing penetrations of countertops - integrally welded stainless steel inverted gusset.

D. Utensil Rack Hooks - Component Hardware Model No. J77-4401 stainless steel hooks spaced 8” OC maximum.

2.13 OPEN BASE STRUCTURES

A. 1-5/8” OD x 16-gauge seamless stainless-steel tubing legs beveled at the bottom. 1¼” OD cross rails fully welded (360° smooth and polished) to legs at 10” AFF, OC.

B. Top of Leg: Inserted in Component Hardware Model No. A20-0206 gusset fully welded to table frame or sink bottom.

C. Bullet Foot: Component Hardware Model No. A10-0851.

D. Freestanding fixtures requiring utility connections: Component Hardware Model No. A10-0854 flanged feet at the fixture corners, anchored to the floor with non-corrosive bolts.

E. Table Bases: Maximum leg spacing of 6’-0” OC; dishtable and utensil wash counter bases at 5’-0” OC.

F. Open Base equipment specified to be supported by brackets at the rear side only (not completely cantilevered): Tubular legs at the front side only with Component Hardware Model No. A10-0854 flanged feet anchored to the floor with non-corrosive bolts. Front-to-back cross rail: fitted into Component Hardware Model No. A20-0406 circular gusset secured to the wall with non-corrosive bolts.

2.14 UNDER SHELVES

A. Open Base Structures: 16-gauge stainless steel turned down 1½" with tight hem at the bottom. Notch all corners to fit tubular legs and weld from the underside to fill the gap, grind, and polish. Cove up 2" at the rear or ends adjacent to wall, columns, refrigerators, etc. The turn-up at freestanding fixtures is to be hemmed tight to the bottom of the turndown. Brace undershelf with 1" x 4" 14-gauge stainless steel channel at the longitudinal centerline and each intermediate pair of legs.

B. Open Base Structure specified to be supported by brackets at the rear side only (not completely cantilevered): 16-gauge stainless steel turned down 1 ½" at free sides with tight hem at the bottom edge. Notch all corners to fit tubular legs as required and weld from the underside to fill the gap, grind, and polish. Cove up 2" at rear ends, as indicated. Fill the gap at the front-to-back rail, grind, and polish. Brace undershelf with 1" x 4" x 1" 14-gauge stainless steel channel at longitudinal centerline between front to back rails.

C. Closed Base Fixtures: 16-gauge stainless steel turned down 1½" at front. Front edge of bottom shelf: Turned back and sealed to finished masonry platform or boxed for leg application. Center shelf has ¾" tight hem.

1. Shelves: Turn up square at ends (coved up at rear only) to the shelf above or countertop flanged out for attachment with no open spaces at interior.

2. All shelf partitions at exposed ends of cabinet bodies or interiors: Free of exposed framing members.

3. Reinforce shelves with full-length 1" x 4" x 14-gauge stainless steel closed hat channel.

4. Unless otherwise noted, all closed base undershelves must be 22" deep and clear.

5. Fully weld smooth and polish the vertical seam of the shelf turndown/turn up with the face of the body partition.

6. Seal the vertical seam of the square turn-in at the exposed interior of open shelf sections.

2.15 ANCHOR PLATES / WOOD GROUNDS

A. Behind the finished surface, wherever building walls, partitions, or ceiling construction will not accommodate direct attachment of equipment such as over shelves, wall cabinets, hose reels, utensil racks, exhaust hoods, display cases, etc. Material and installation by General Contractor. Location and coordination with trades by Section 114000.

B. Anchor Plates: Not less than 12" x 12" x ¼" thick steel, secured to the structure above or behind the finished surface, positioned at attachment points.

C. Wood Grounds: Length required by fixture, component, or device, 24" wide x ¾" thick plywood secured to partition system before gypsum board installation.

D. Above ceiling supports: Structural shapes (4” x 8.0 lb. channel) suspended from the structure. Maximum height 15’-0” AFF. Size: width of equipment x length of equipment plus 6’-0”. Cross bracing at 6’-0” OC maximum.

2.16 OVER SHELVES

A. 16-gauge stainless steel with free edges turned down 1” with ½” tight hem at the bottom—¾” radius at free corners.

B. Turn up 2” raw at walls and sides with a horizontal coved corner at the rear. Round front corners of turn up on ¾” radius.

C. Where shelf width exceeds 12” width, reinforce with ½” x 4” x 14-gauge stainless steel closed hat channel full-length of the shelf.

D. Wall-Mounted Shelves: 16-gauge stainless steel brackets 48” OC maximum, set in 6” from ends.

E. Freestanding Shelves: Where splash is required at free over shelves, turn up square 2” at ends, cove up at the rear, and hem tight to lower edge of front turndown. Weld exposed corners.

1. Freestanding over shelves: 16-gauge stainless steel cantilevered brackets at the rear of the table; double-cantilevered brackets at the center of the table. Posts for cantilevered over shelves are 1-5/8” OD x 16-gauge stainless steel secured to the underframe, 4’-0” OC. Ends of shelves: Secured to adjacent wall/fixture or mounted on 1¼” diameter stainless steel posts.

2. Freestanding over shelves not on cantilevered brackets: 1¼” OD x 16-gauge stainless steel posts, each pair at 4’-0” OC maximum.

2.17 EXHAUST HOODS (SURFACE-MOUNTED CONDENSATE)

A. Hoods: Size/shape as indicated: 18” high on the interior.

B. Body: 16-gauge stainless steel, with all seams welded, ground, and polished.

C. Continuous condensate trough at perimeter: 3” x 1”.

D. Frame the top of the hood with 1½” angle iron assembly and suspend from the structure above the ceiling by ½” diameter steel rods, drawn tight against the finished ceiling surface.

E. Duct opening/collar as specified with stainless steel louvered grille over the opening.

F. Div. 22 to extend drain line to floor sink when shown. The drain line is to be silver painted. Div. 22 to ensure all drain lines are centered over floor sink grate openings and no water splashes on the floor.

G. ½" diameter steel hanger rods at 4'-0" OC maximum to be by Kitchen Equipment Contractor, but they are to be anchored to the supporting structure (or slab) by the General Contractor in the locations required by exhaust hood shop detail.

H. Hoods and components to meet all NSF standards, NFPA 96, UL 710 and current IECC requirements.

2.18 HIGHLIGHTING

A. Polish the following vertical surfaces to a No. 8 finish:

1. Conveyor and dish/tray deposit station turndowns/frame.

2.19 SHOP / FIELD JOINTS

A. Field joints: The least number is used only when equipment size must be limited for building or interior space access.

B. Stainless steel tops (including edges and splashes): Fully welded, ground, and polished to match adjacent surfaces.

C. Vertical field joints of fixture backsplashes that are inaccessible from the back: terminate 1" above the horizontal coved corner. The remaining height of the field joint: hairline butt joint with offset draw-angle behind. All horizontal/vertical draw joints: located and noted on shop drawings.

D. Hairline butt joint: 1½" x 1½" x 1/8" steel angles welded to the back/underside of countertop/shelf. Offset angle beyond joining metal edge ½" (min.) to provide a flat backing surface for a joint with the angle of other joining metal edge, set for ½" space between vertical legs of angles. Bolt sections together with 5/16" machine bolts, lock washers, acorn head cap nuts, set 3" OC.

E. Solid Polymer: Surfaces drawn tight, filled, sanded, and finished to match adjacent surfaces.

2.20 PRE-APPROVED KITCHEN EQUIPMENT CONTRACTORS

A. Only the following named Subcontractors and those approved later, if any, are approved for inclusion in the Contractor's Bid.

B. **Any contractor requesting inclusion within this bid must submit AIA form 305 a minimum of 14 days before the bid date for review or as required by Architect.**

1. Stafford Smith, Mr. JP Garcia, 7129 North Loop East, Houston, TX 77028, Phone: 713.892.5001, Email: jpgarcia@staffordsmith.com

2. Texas Metal Equipment Company, Mr. Andrew Harman, 6707 Mayard, Houston, Texas 77041, Phone: 713.466.8722, Email: aharman@txmetalequip.com

3. Kirby Restaurant Supply, Mr. Brian Kernan, 809 S. Eastman Road, Longview, Texas 75602, Phone: 903.757.2723, Email: briank@kirbysupply.com

4. Mission Restaurant Supply, Mr. Bruce Walker, 6509 N Lamar Blvd, Austin, Texas 78752, Phone: 512.389.1705, Email: bruce@missionrs.com

5. Kommercial Kitchens, Mr. Terry Woodard, 13544 East Fwy., Houston, TX 77015, Phone: 409.769.1199, Email: terry@kommercialkitchens.com

6. Supreme Fixtures Co., Inc., Mr. Tim Hampel, 11900 Vinny Ridge Road, P.O. Box 193655, Little Rock, AR 72219, Phone: 501.455.2552, Email: tim@supremefixture.com

7. Amundsen Commercial Kitchens, Mr. Lewis Beville, 105 Montie, Longview, TX 75604, Phone: 903.576.6354, E-mail: lewis@afeok.com

2.21 PRE-APPROVED STAINLESS-STEEL FABRICATION SUPPLIERS

A. Only the following named Subcontractors and those approved later, if any, are approved for inclusion in the Contractor's Bid. Pre-approved fabricators shown below shall not sub-out fabrication.

B. **Any supplier requesting inclusion within this bid must submit AIA form 305 at least 14 days before the bid date for review or as required by Architect.**

1. Texas Metal Equipment Company, Mr. Andrew Harman, 6707 Mayard, Houston, Texas 77041, Phone: 713.466.8722, Email: aharman@txmetalequip.com

2. Kommercial Kitchens, Mr. Terry Woodard, 13544 East Fwy., Houston, TX 77015, Phone: 832.767.5287, Email: terry@kommercialkitchens.com

3. Mission Restaurant Supply, Mr. Bruce Walker, 6509 N Lamar Blvd, Austin, Texas 78752, Phone: 512.389.1705, Email: bruce@missionrs.com

4. CSS Manufacturing, Mr. Jared Woodard, 7430 Fairbanks North Houston Rd., Houston, Texas 77040, Phone: 832.444.6311, Email: jared.woodard@css-mfg.com

PART 3 - EXECUTION

3.1 DELIVERY AND INSTALLATION

A. Supervision: Provide a skilled and proficient foreman or supervisor who shall remain on the job during the entire installation.

B. Delivery: Coordinate with the progress of construction and Owner's operation schedules. Unless otherwise instructed and documented by Owner or General Contractor, the following procedures apply:

1. Field-Assembled Fixed Equipment integrated into the structure (e.g., exhaust hoods, drain trench/grate assemblies, conveyor systems, ceiling-mounted

utensil racks, etc.) are to be sent to the job site when directed by the General Contractor and installed/protected accordingly.

2. All other Fixed Equipment: delivered after completion of work on adjacent finished ceilings, lighting, finished floor and wall systems, including painting.

3. Major Movable Equipment: delivered, when possible, to inventory in a secured area for interim job-site storage or, if the secured area is unavailable when fixed equipment installation/clean-up has been completed.

4. Minor appliances and loose items (e.g., pans, covers, flatware containers, etc.) should be delivered only when the Owner is prepared to receive and inventory such items.

C. Installation: performed by the manufacturer of custom fabricated fixtures.

1. Assemble, square, level, and ready all items for the final utility connections.

2. Cut neatly around obstructions to provide sanitary conditions.

3. Where gaps of ¼" or less occur adjacent to or between equipment, insert rope backing and smoothly apply General Electric construction sealant Series SE-1200 silicone mastic (silver color). Mask both sides of the gap for neat sealant application and remove excess. If space exceeds ¼," neatly install 18-gauge stainless steel trim molding of proper shape with concealed attachment. Use epoxy cement or "Z" clips wherever possible to secure stainless steel trim. Exposed edges or corners of trim: eased and smooth.

D. Protection of Work:

1. Fabricated fixtures: Fiberboard or plywood taped to tops and exposed body panels/components.

2. Manufactured Equipment: Fiberboard or plywood taped as required by equipment shape and installation-access requirements.

3. Prohibited use of equipment: Tool and materials storage, workbench, scaffold, stacking area, etc.

4. Damaged Equipment: Immediately documented and submitted to the Owner with the Contractor's recommendation of action for repair or replacement and its impact on the Project Schedule and Contract Amount, if any.

3.2 CLEAN AND ADJUST

A. Clean up and remove all debris from this Work from the job site as the installation progresses.

B. Lubricate and adjust drawer slides, hinges, and casters.

C. Adjust pressure regulating valves, timed-delay relays, thermostatic controls, temperature sensors, exhaust hood grilles, etc.

D. Clean or replace faucet aerators and line strainers.

E. Touch-up damage to painted finishes.

F. Start up and check the operation of all refrigeration systems for at least 72 hours before acceptance.

3.3 EQUIPMENT START-UP/DEMONSTRATION

A. Carefully test, adjust, and regulate all equipment following the manufacturer's instructions and certify in writing to the Owner that the installation, adjustments, and performance are in full compliance.

B. Provide the Owner or food service Operators with a thorough operational demonstration of all equipment and furnish instructions for general and specific care and maintenance. Coordinate and schedule selected equipment items and attendees with the Owner at least two weeks before the demonstration starts.

3.4 FINAL OBSERVATION

A. Final observation will be made when the Contractor certifies that they have completed their work, thoroughly reviewed the installation/operation of each item in the contract and found it to comply with the Construction Documents.

B. Repetitive final observations (more than two) and all costs associated with it which may be incurred due to the Contractor's failure to comply with the requirements of this Article will be invoiced to this Contractor on a $70.00/hr and expense basis.

PART 4 - EQUIPMENT SCHEDULE

4.1 REGULARLY MANUFACTURED EQUIPMENT/COMPONENTS: Standard finishes and accessories unless specifically deleted or superseded by the Contract Documents.

4.2 FABRICATED AND FIELD-ASSEMBLED EQUIPMENT: Arrangement and configuration as shown on Plans, Elevations, Detail Drawings, and outlined in Specifications.

4.3 REFER TO DRAWINGS: For unit quantities and plumbing, electrical or mechanical provisions are required, including the manufacturer's optional voltages, wattages, burner capacities, etc.

4.4 REFER TO PART 2 – PRODUCTS: For accessories, fittings, requirements, and procedures related to the listed buy-out and fabricated equipment.

4.5 ALTERNATE MANUFACTURER REQUIREMENTS: A specific product manufactured by the listed pre-approved equals shown under Section 4.7 Food Service Equipment are acceptable only if the specific product can evidence compliance with the specified line items and the contract documents (Refer to Section 1.6; Sub-Section A.).

4.6 RE-USED EXISTING EQUIPMENT IF PROVIDED IN THIS PROJECT

A. Existing equipment scheduled for re-use is to be inventoried and documented that equipment is in operating condition once Kitchen Contractor has taken ownership.

B. Provide pictures of all equipment once inventoried and issue them to the architect to ensure that equipment has not been damaged.

C. Verify the locations of all equipment with the owner.

D. Existing equipment that is to be reused may need parts or accessories for proper and complete operation. Submit a report listing all items with pricing for approval to allow complete installation.

E. Utility disconnection and re-connection: Under Divisions 22 and 26. Kitchen Contractor to verify utility requirements of existing equipment and coordinate with Foodservice Design Professionals (FDP) as required. If utilities shown on FDP drawings do not match the requirements of existing equipment – KEC is to relay that to FDP immediately. All utilities not scheduled for re-use must be capped and covered by required disciplines.

F. Disassembly, removal, transportation, and relocation: under this Section and scheduled with General Contractor. The owner's representative must be present and coordinate the date/time with the owner.

G. Thoroughly clean inside and out before relocation.

H. Review functional parts (e.g., doors, controls, heating elements, compressors, etc.) and submit a report of required repairs and cost estimates. Any finishes or equipment damaged due to construction will be repaired as required.

I. Existing equipment not scheduled for reuse is to be carefully removed/relocated by the Kitchen Contractor per the Owner's direction. Kitchen Contractor to coordinate the date/time with General Contractor and Owner.

J. Removal or replacement of existing equipment is to be scheduled for times of least interruption and inconvenience to the food service operation. Submit the proposed time frame schedule, task sequence, and process for approval before starting work.

K. Kitchen Contractor to verify size and shape for all existing re-used equipment and coordinate with Foodservice Design Professionals (FDP) as required.

L. Any modification(s) required/desired for re-used existing equipment to be verified by the Kitchen Contractor. Before the changes are made, all modifications must be approved by the Owner and Foodservice Design Professionals (FDP).

M. The KEC is to verify and coordinate all the utility requirements with the construction documents as required. Refer to the general specifications regarding conflicts.

4.7 FOOD SERVICE EQUIPMENT

A. All equipment is to have a performance check from factory-authorized personnel. Warranties will begin on the day of the performance check.

B. All equipment and internal components should be of domestic origin where possible.

C. Architect to verify/coordinate the aesthetic options below (Food Service color, material, or signage selections) if these items are provided in this project:

D. Architect to verify/coordinate the finishes below:

1. Walls: Ceramic Tile, Flat FRP, or Molded FRP (Smooth, Impervious, and easily cleanable as approved by local jurisdiction)

2. Ceilings: Removable Vinyl Face Tile (Smooth, impervious, and easily cleanable as approved by local jurisdiction)

3. Floors: Tile, Epoxy, or Rubberized flooring system (Smooth, impervious, easily cleanable and slip resistant as approved by local jurisdiction) (Coordinate floor tile transition at serving lines)

4. Floors: Walk-in Assembly – Extend kitchen floor flush into Walk-in assembly with coved base

5. Furr Downs above Serving Counters

ITEM NO. 105 DUNNAGE RACK

QUANTITY 2

Manufacturer:	Metro
Model:	Bow Tie Series
Size and Shape:	Refer to drawings
Alternate:	

1. Size as shown.

ITEM NO. 107 DRY STORAGE SHELVING

QUANTITY 3

Manufacturer:	Metro
Model:	MetroMax Q
Size and Shape:	Refer to drawings
Alternate:	Cambro Camshelving

1. Each unit to be five (5) tiers high with open grid shelving.
2. Four (4) 86" posts per unit.
3. Refer to drawings for size, width and lengths.
4. Verify shelving requirements with approved submittal prior to ordering.

ITEM NO. 107A DRY STORAGE SHELVING - EXISTING - RELOCATE

QUANTITY 1

Manufacturer:	Metro
Model:	Existing- Relocate
Size and Shape:	Refer to drawings
Alternate:	---

1. Refer to General Specifications re: 4.6 RE-USED EXISTING EQUIPMENT IF SHOWN

2. Quantity One (1) to equal One (1) Lot: all shelving shown within the dry storage room.
3. KEC to coordinate relocation of all equipment per owners direction.
4. Refer to drawings for size, width and lengths.
5. KEC to inventory all equipment and condition prior to removal from existing facility.

ITEM NO. 109 ICE MACHINE WITH BIN - EXISTING - RELOCATE

QUANTITY 1

Manufacturer: ---
Model: Existing- Relocate
Size and Shape: Refer to drawings
Alternate: ---

1. Refer to General Specifications re: 4.6 RE-USED EXISTING EQUIPMENT IF SHOWN
2. Relocate existing ice machine from current kitchen.
3. KEC to coordinate relocation of all equipment per owners direction.
4. KEC to inventory all equipment and condition prior to removal from existing facility.
5. Provide sizes and quantities as required: Dormont s/s water disconnect from filter to Ice Machine.
6. Interconnection thru water filter to ice machine and final connection by Division 22. Water filter overflow tube to be strapped to back side of ice machine and extend to 1" above floor sink.
7. **Special Instructions:** GC to disconnect all utilities as required.

ITEM NO. 123 DISPOSER - SINK MOUNT

QUANTITY 1

Manufacturer: Salvajor
Model: 300-CA-18-ARSS -LD
Size and Shape: Refer to drawings
Alternate: In-Sink-Erator

1. Fixed nozzle.
2. Delete standard syphon breakers and provide T & S B-0456-04 vacuum breakers and mount 6” from tabletop to base of breaker.
3. Solenoid valve.
4. Flow control.
5. Model no. ARSS-LD control panel.
6. Auto-reverse.
7. Dejamming tool.
8. Install vacuum breaker in splash
9. S/S cone cover.
10. Perforated silver saver and disposer cone with scrap ring.
11. Two (2) Swirl inlet located in disposer cone at a 45 degree angle.
12. GC to pipe 1/2" cold water to disposer body and swirl inlets. Excess electrical cord to be secured to fabrication as required. Install into counter by section 114000.

ITEM NO. 139 INSUL MOBILE PROOFER - EXISTING - RELOCATE

QUANTITY 1

Manufacturer:	---
Model:	Existing- Relocate
Size and Shape:	Refer to drawings
Alternate:	---

1. Refer to General Specifications re: 4.6 RE-USED EXISTING EQUIPMENT IF SHOWN
2. Relocate existing proofer from current kitchen.
3. KEC to coordinate relocation of all equipment per owners direction.
4. KEC to inventory all equipment and condition prior to removal from existing facility.
5. **Special Instructions:** GC to disconnect all utilities as required.

ITEM NO. 159 CONDENSATE HOOD

QUANTITY 1

Manufacturer:	Mod-U-Serve
Model:	CH
Size and Shape:	Refer to drawings
Alternate:	Avtec, Accurex

1. Hood to meet requirements of ALL current local Mechanical and local Energy Codes.
2. Refer to drawings for size and location.
3. Ventilator shall be manufactured with a full perimeter gutter with drain extended to floor sink. General Contractor to extend drain to floor sink.
4. Stainless steel enclosures to ceiling at all open sides.
5. Coordinate dish machine doors with condensate hood.
6. Entire system to be in compliance with NFPA pamphlet #96 and local governing code authorities, and shall be in accordance with Division 23. Shall be U.L. listed.
7. Manufacturer to check out system after installation to verify actual exhaust and supply air quantities and certify that performance is as designed and provide written report.
8. 1/2" diameter steel hanger rods at 4'-0" O.C. maximum to be by Kitchen Equipment Supplier, but they are to be anchored to supporting structure (or slab) by the General Contractor in the locations required by exhaust hood shop detail.
9. Start up and performance check to be provided by Manufacturer Service Agency. Manufacturer warranty to start on this date.

ITEM NO. 167 MOBILE WORKTABLE

QUANTITY 3

Manufacturer:	Custom Fabricated
Model:	---
Size and Shape:	Refer to drawings
Alternate:	---

1. Top: 14 gauge type 304 S/S with 2" turndown at all sides.
2. Open base construction.
3. 16 gauge S/S undershelf per drawings.
4. Two (2) 20" W x 20" L drawer assemblies. Component Hardware #S52-2020 drawer slides with delrin bearings - 200lb capacity. Component Hardware #S81-2020C drawer pan.
5. 5" N.S.F. approved non-marking swivel casters, two with brakes.

ITEM NO. 249 THREE COMPARTMENT SINK NO DISPOSER

QUANTITY 1

Manufacturer:	Custom Fabricated
Model:	---
Size and Shape:	Refer to drawings
Alternate:	---

1. Top: 14-gauge S/S 3" high 1-1/2" rolled rim at free sides, 10" high splash at walls.
2. Open base construction.
3. Omit rear rail at sink.
4. Three (3) 30" x 26" x 15" deep sink compartment.
5. Two (2) T&S model no. B-0291, splash mount faucet, 18" swing nozzle, LL inlets, for ¾" hot and cold water connections.
6. Three (3) Fisher 22306 twist waste valve 3 1/2" x 2" with overflow and tailpiece. Provide 18 gauge S/S bracket for drain handle welded to sink bottom.
7. 12" deep single post mounted perforated overshelf mounted at 18" above counter top.
8. 18-gaugebutt joint wall panel from splash to underside of shelf.
9. Post mounted utensil rack, extend 1-5/8" diameter S/S post from back splash, turn forward 12" and weld full length x 2" x ¼" S/S bar with Component Hardware model no. V-77-4401 S/S sliding hooks at 8" on center.
10. 16-gauge S/S undershelf as per drawings.
11. Flanged feet at front only of counter.
12. Anchor flanged feet to floor with non-corrosive bolts. Secure wall mounted equipment / components to in wall grounds or anchor plates. Coordinate installation with the general contractor.

ITEM NO. 250 CONVEYOR DISHMACHINE W. EXTERNAL BOOSTER

QUANTITY 1

Manufacturer:	Hobart
Model:	CL44-BAS
Size and Shape:	Refer to drawings
Alternate:	Champion

1. Dishwasher, conveyor type, single tank design, 202 racks/hour capacity, S/S construction, with automatic fill, auto timer, and 115 volt pilot circuit.
2. 15 KW Electric tank heat.
3. 480/60/3.

4. Verify direction of dishmachine with drawings.
5. One (1) Extended warranty - One (1) Year parts and labor.
6. Interior Chamber height to be 4" taller than standard.
7. Single point electrical connection for Motors, Controls and Tank Heat. Div. 26 to provide S/S disconnect switches located as per plans interconnected to dishmachine and external booster heater.
8. One (1) table limit switch with stainless steel cover to conceal back. Provided by Manufacturer / Installed by Div. 26.
9. Four (4) 20"x20" Peg racks.
10. Four (4) 20" x 20" sheet pan racks.
11. Two (2) 20" x 20" combination racks.
12. Vent fan controls.
13. Drain water tempering kit. Drain water tempering kit is to be installed by Hobart Service.
14. Peak Rate of drain flow = 38 gpm. Division 22 to provide and install backflow preventor between booster heater and filter. Final connection by Division 22. Coordinate location of electrical disconnects on free wall.

ITEM NO. 252 BOOSTER HEATER

QUANTITY 1

Manufacturer:	Hatco
Model:	C-24
Size and Shape:	Refer to drawings
Alternate:	---

1. Compact booster heater.
2. One (1) Brass Pressure Reducing Valve with By-Pass.
3. 6" adjustable S/S legs.
4. One (1) Phosphate water treatment unit. System to be located in an accessible location. **Provide Scaltrol Filter model #HSC-100 for Booster Heater.**
5. One (1) Shock Absorber.
6. S/S body and base.
7. Division 22 to provide and install backflow preventor between booster heater and filter. Final connection by Division 22. Interconnect to dishmachine by Division 22. Coordinate location of electrical disconnects on free wall. GC to insulate hot water from booster heater to dishmachine.

ITEM NO. 254 SOILED & CLEAN DISHTABLE

QUANTITY 2

Manufacturer:	Custom Fabricated
Model:	---
Size and Shape:	Refer to drawings
Alternate:	---

1. Top: 14 gauge type 304 S/S 3" high 1-1/2" rolled rim at free sides. 10" high splash at walls.

2. 14 gauge S/S recessed deposit shelf. Extend shelf through opening to be flush with wall at deposit side. Turn shelf down 2" at front with ¾" return at bottom (either scribed into partition or forming reveal). Shelf: integral with dishtable. Provide Component Hardware E32-4900 drain - extend drain line to floor sink.
3. 18 gaugebutt joint wall panel from splash to underside of shelf.
4. Modify rolled rim at the operators side of the tray drop window to have a 3" rolled rim.
5. Install Disposer as shown. Notch and punch splash turn back for vacuum breaker. 12 gauge S/S bracket mounted below counter top and polished to match top for disposer control panel.
6. Provide One (1) T&S model no. B-0133-EE pre-rinse, B-0108-C spray head, two (2) B-0109-04 18" long wall bracket (dealer to cut to correct length), one (1) additional spray face model no. 108SFRK with ceramic cartridges.
7. One (1) Chicago model no. 305-VBRCF hose bibb and rack mounted on 12 gauge S/S bracket ground and polished to match top. Hose and spray rinse by owner.
8. One (1) 18" disposer cone.
9. Removable S/S rack guide assembly, when sink is shown.
10. Provide ½" slope in top towards dishmachine per the general specifications.
11. Coordinate dishtable with existing roll down door and frame..
12. S/S corner filler at backsplash; slope to dishtable.
13. S/S cover to conceal table limit switch.
14. 2 1/2" backsplash at dishmachine portion, single thickness of s/s will not be accepted.
15. Anchor flanged feet to floor with non-corrosive bolts. Secure wall mounted equipment / components to in wall grounds or anchor plates. Coordinate installation with the general contractor.

ITEM NO. 255 MOBILE DRYING RACK

QUANTITY 4

Manufacturer:	Metro
Model:	Metro Max4 Series
Size and Shape:	Refer to drawings
Alternate:	Cambro Camshelving

1. Four (4) tier, includes two (2) drop-ins and (1) cutting board/tray drying rack, built in Microban antimicrobial product protection.
2. Two (2) no. 5MPX casters per unit.
3. Two (2) no. 5MPBX locking casters per unit.

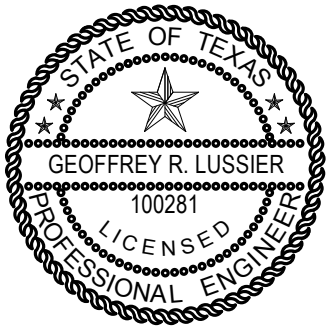
END OF SECTION 114000

SOUR LAKE KITCHEN ADDITION
HARDIN-JEFFERSON ISD

DIVISION 21 – FIRE PROTECTION SYSTEMS

DIVISION 22 – PLUMBING

E&C Engineers & Consultants, Inc.
TX Firm Registration No: F-003068
Date: 12-30-2024
Engineer of Record: Geoffrey Lussier, PE
State: Texas
License no: 100281



THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY:

Geoffrey Lussier
2024.12.30
13:27:15-06'00'

E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

SECTION 211313 – FIRE PROTECTION SYSTEMS

PART 1 GENERAL

1.01 The following sections are to be included as if written herein:

A. Section 23 00 10 – Mechanical Scope of Work

B. Section 23 03 00 – Sleeves, Flashings, Supports and Anchors

C. Section 23 03 00 – Mechanical Identification

1.02 SECTION INCLUDES

A. Pipe, fittings, valves, and connections for sprinkler, standpipe and fire hose, and combination sprinkler and standpipe systems.

1.03 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS

A. Section 23 07 00 - Piping Insulation: Placement of pipe sleeves

1.04 RELATED SECTIONS

A. Section 31 23 16.13 - Trenching

B. Section 09 91 00 - Painting.

C. Section 22 10 10 - Piping, Valves and Fittings

D. Section 23 05 48 - Vibration Isolation.

1.05 REFERENCES

A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.

C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

E. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.

F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.

G. ANSI/ASME B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.

H. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

I. ANSI/ASME B16.25 - Buttwelding Ends.

J. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

K. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

L. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.

M. ANSI/ASTM A47 - Malleable Iron Castings.

N. ANSI/ASTM B32 - Solder Metal.

O. ANSI/AWS A5.8 - Brazing Filler Metal.

P. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.

Q. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.

R. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

S. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.

T. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

U. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

V. ASTM B75 - Seamless Copper Tube.

W. ASTM B88 - Seamless Copper Water Tube.

X. ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

Y. ASTM F442 - Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).

Z. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

AA. NFPA 13 - Installation of Sprinkler Systems.

BB. NFPA 14 - Standpipe and Hose Systems.

CC. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances

DD. UL - Fire Protection Equipment Directory.

EE. Texas, Fire Department Standards.

FF. State of Texas, State Fire Marshal Rules and University of San Jacinto Fire Marshall Requirements.

GG. All hose threads, coupling types, etc., utilized in the fire protection systems shall conform to the standards and requirements of the local city fire code, Texas Fire Department and SJC fire marshal.

1.06 SUBMITTALS

A. Submit under provisions of Section 23 01 00.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Product Data: Provide data on sprinkler heads, valves, and specialties, including manufacturer's catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds requirements specified, and suggested by listed codes.

E. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 01 00.

B. Maintenance Instructions: Include installation instructions, spare parts lists, procedures, and treatment programs.

1.08 QUALITY ASSURANCE

A. Sprinkler Systems: Perform work to NFPA 13-2013.

B. Standpipe and Hose Systems: Perform to NFPA 14-2013.

C. Welding Materials and Procedures: Perform to ASME Code.

D. Equipment and Components: Bear U.L. label or marking. Provide manufacturer's name and pressure rating marked on valve body.

E. Maintain one copy of each document on site.

F. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal

documents and shop drawings shall bear the responsible engineers signed and dated seal.

G. All parts of fire protection piping systems shall conform to all provisions of Underwriters' Laboratories requirements. All equipment shall bear the Underwriters' Laboratories label of approval.

H. Determine volume and pressure of incoming water supply from residual pressure water flow test.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 23 01 00.

B. Deliver and store valves in shipping containers, with labeling in place.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.01 WALL, FLOOR AND CEILING PLATES:

A. See Section 23 03 00.

2.02 SLEEVES, INSERTS, AND FASTENINGS:

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, etc., shall be sleeved.

B. See Section 23 03 00.

2.03 UNIONS:

A. See Section 23 03 00.

2.04 FLANGES:

A. See Section 23 03 00.

2.05 BACKFLOW PREVENTERS: Backflow preventers (BFP) shall be reduced pressure type, Febco 825, or approved equal. A BFP shall be installed to isolate all non-potable water requirements from the building domestic water system. (All BFP's shall be installed within the building.)

2.06 MATERIALS:

A. PIPING:

1. All pipe used for fire protection standpipe systems and fire sprinkler systems shall be Schedule 40 black steel pipe. See Section 23 03 00. All piping 2 1/2" or smaller must be threaded, 3”or larger must be welded.

2. Use of piping, when approved by SJC System, shall be “roll” grooved type and must be UL approved. Cut grooved pipe is not permitted.

3. No pipe smaller than 4" nominal pipe size shall be used for standpipe systems.

4. Scheduled 10 pipe is not permitted.

B. FITTINGS:

1. All welding type steel fittings employed in fabricating fire protection standpipe system and fire sprinkler systems shall conform to A.S.T.M. Specification A-234 and ANSI Standard B16.9-1964. All threaded fittings shall be class 150 300 pound malleable iron fittings. Grooved type fittings will not be accepted for use in standpipe systems unless specifically indicated. Pipe size changes shall be performed through the use of reducing tees or reducers designed for that purpose. The use of bushings is explicitly prohibited.

2. Unless otherwise shown or required, all fittings shall be welding type steel fittings. See Section 23 03 00.

3. Threaded fittings shall be used from the point of connection of the pipe to the riser to each fire hose cabinet. Threaded fittings shall be Crane or Grinnell Company's class 150 300 pound malleable iron fittings.

4. Grooved end couplings 2 ½” and larger shall be Victaulic Style 005 Rigid Coupling, with EPDM gasket for use with roll grooved horizontal piping and style 007 on vertical standpipes. Products by Gustin-Bacon, Gruvlok are acceptable, or Engineer-approved equal. Reducing type couplings, outlet couplings, “T” outlet fittings, cut-in style fittings, snap joint couplings, and flange adapter type fittings are not acceptable. Provide grooved fittings similar to standard weld fittings.

5. Extra heavy "Thread-o-lets" shall be used at each point of departure from the riser to the fire hose or valve cabinet. A "Thread-o-let" shall be installed below the level of the valve in the cabinet and a minimum of two (2) threaded ells shall be used to provide a swing joint connection from the riser to the valve in the cabinet.

6. Refer to Section 23 03 00 for additional requirements.

2.07 VALVES:

A. See Section 23 20 00.

2.08 SPRINKLER SYSTEM

A. SYSTEM DESCRIPTION

1. System to provide coverage for entire building.

2. Provide system to NFPA 13 light hazard occupancy requirements unless otherwise noted.

3. Interface system with building fire and smoke alarm system.

B. SUBMITTALS

1. Submit under provisions of Section 23 01 00.

2. Preliminary Shop Drawings: Prior to detailed submission, submit preliminary layout of finished ceiling areas indicating only head locations coordinated with ceiling installation.

3. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls. Submit copies to University Fire Marshal and A/E for review.

4. Submit revised shop drawings, product data, and hydraulic calculations and review comments to Architect/Engineer and to University Fire Marshall for review.

5. Samples: Submit two of each style of sprinkler head specified.

C. PROJECT RECORD DOCUMENTS

1. Submit under provisions of Section 23 01 00.

2. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.

D. OPERATION AND MAINTENANCE DATA

1. Submit under provisions of Section 23 01 00.

2. Maintenance Data: Include components of system, servicing requirements, Record Drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

E. QUALITY ASSURANCE

1. Perform Work in accordance with NFPA 13.

2. Equipment and Components: Bear U.L. label or marking.

3. Maintain one copy of all documents on site.

F. EXTRA MATERIALS

1. Furnish under provisions of Section 23 01 00.

2. Provide extra sprinkler heads as suggested under provisions of NFPA 13.

3. Provide suitable wrenches for each head type.

4. Provide metal storage cabinet in location designated.

G. PRODUCTS

1. General: The Contractor shall provide all components required for the complete installation of automatic sprinkler systems as hereinafter specified and indicated on the Drawings.

2. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association and Fire Protection and Engineering Bureau of Texas, or by an authorized agent of such firm. Evidence to support the above requirements may be required and any proposed installer who cannot show suitable experience will be rejected.

3. System Layout: The fire sprinkler areas, piping, head locations, etc. as indicated is only for Contractor's reference as to areas to be protected and possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire sprinkler system as described herein and on the project drawings. The piping of the system shall be sized used the "hydraulic" method, as included in NFPA Standard No. 13. Piping sized using the "schedule" method is unacceptable, except where expanding an existing "scheduled" system.

4. Shop Drawings: Shop Drawings shall be submitted prior to fabrication. The Shop Drawings shall include detail plans of sprinkler systems including piping sizes, sections and plot plan indicating the locations of underground supply connections, control valves, fire department connections, and other

equipment to be used. The Shop Drawings shall become an integral part of these Specifications.

5. Materials and Equipment:

   a. General: All materials and equipment used in the installation of the sprinkler system shall be listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials, or the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard, and shall be the latest design of the manufacturer. All piping, control valves, drain valves, fittings, etc. shall be as specified under this Section, Fire Protection System, & in Section 23 0300.A utilizing welded, flanged, and threaded fittings only. Where valves are not specified by Figure No. they shall be of specified manufacture, U.L. listed for service, and of same quality level as Figure Nos. specified. All pipe 3”" and larger shall be welded, except as may be allowed herein. All pipe 21/2" and smaller shall be threaded using 125 pound cast iron, A135 Schedule 40 black steel pipe and fittings. Note that if galvanized pipe or fittings are installed in other than dry systems, the contractor shall be responsible to remove the galvanized pipe or fittings and replace them with specified materials as soon as possible prior to further installation of the system.(EXCEPTION: Dry pipe systems shall be hot dipped galvanized pipe and fittings of same schedule as dry systems, per Factory Mutual recommendations.)

6. Sprinkler Heads:

   a. Unless otherwise specified or indicated on the Drawings, sprinkler heads shall be quick response type spray heads of the upright or pendant ordinary degree temperature rating type except that sprinkler heads to be installed in the vicinity of heating equipment and lights shall be of the temperature rating required for such locations by National Fire Protection Association Standard No. 13. *Ceiling sprinklers shall be Grinnell RFII “ROYAL FLUSH” white concealed sprinkler heads. Uprights shall be Grinnell No. F950 brass upright.*

   b. Heads shall be located in a symmetrical pattern related to ceiling features such as grid, beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrically with the ceiling grid, centered in two directions.

   c. The Contractor shall provide spare heads equal to one percent (1%) of the total number of heads installed under the Contract, but not less than ten (10). The heads shall be packed in a suitable wall mounted sprinkler cabinet and shall be representative of, and

in proportion to, the number of each type and temperature rating heads installed. In addition to the spare heads, the Contractor shall provide not less than one special sprinkler head wrench for each type of head. The cabinet shall be located where directed by the Construction Inspector.

7. Piping: Installation of piping, fittings and valves shall be as specified in Chapter 3, System Components, NFPA Standard No. 13, except where noted otherwise. Piping shall be concealed in all areas with finished ceilings. Piping shall be sterilized as specified in Section 23 20 00. The O.S. & Y. valves shall be provided under Section 23 20 00.

   Note that the use of piping bushings for any purpose is explicitly prohibited.

8. Electrical Alarm Bell: An electric alarm bell shall be connected to alarm check valve and shall activate an electric alarm bell located on the exterior of the building as directed by the Architect. Alarm bell finish to be selected by the Architect. The alarm valves shall be Underwriters' Laboratories approved, wet type, connected to water supply and indicated on the Shop Drawings. Each alarm valve shall be provided with a circuit closer. Valves shall conform to the equipment of NFPA Standard No. 13, complete with retarding chamber and pressure switch.

9. Water Flow Alarm Switch: Provide, where indicated on the Drawings, McDonnell UL approved line size flow switches. Flow switch shall be provided with delay, adjustable up to 90 seconds (60 to 90 seconds in Austin). See Division 26 for electrical signal connection by others to these flow switches.

10. Hydrostatically test entire system per NFPA 13 procedure and at 200 psi or 50 psi above working pressure, whichever is greater for 2 hours.

11. Require test be witnessed by campus Fire Marshal.

12. Add locations and hazards as required by project conditions.

Location	System Type/Hazard
Offices	Light Hazard
Kitchen areas	Ordinary Hazard, Group 2

2.09 STANDPIPE SYSTEMS:

A. General: The Contractor shall provide all components required for the complete installation of standpipe systems as hereinafter specified and indicated on the Drawings.

B. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association

and Fire Protection and Engineering Bureau of Texas and must have 5 years experience and be licensed by the state of Texas.

C. System Layout: The fire zones, piping, etc. as indicated is only for Contractor's reference as to areas to be protected and for possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and locations, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire system as described herein and on the project drawings.

D. Shop Drawings: Shop Drawings shall be submitted prior to fabrication. The Shop Drawings shall include detail plans of systems including piping sizes, sections and plot plan indicating the locations of underground supply connections, control valves, fire department connections, and other equipment to be used. The Shop Drawings shall become an integral part of these Specifications.

E. Materials and Equipment:

1. General: All materials and equipment used in the installation of the sprinkler system shall be listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials, or the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard, and shall be the latest design of the manufacturer. All piping, control valves, drain valves, fittings, etc. shall be as specified under this Section, utilizing welded, flanged, and threaded fittings only. Where valves are not specified by Figure No. they shall be of specified manufacture, U.L. listed for service, and of same quality level as Figure Nos. specified. All pipe 3”" and larger shall be welded, except as may be allowed herein. All pipe 2 1/2" and smaller shall be threaded using 125 pound cast iron, A120 Schedule 40 black steel pipe and fittings. Note that if galvanized pipe or fittings are installed, the contractor shall be responsible to remove the galvanized pipe or fittings and replace them with specified materials as soon as possible prior to further installation of the system.

2.10 SIAMESE CONNECTIONS:

A. At the points designated on the accompanying Drawings, install Siamese fittings required for fire protection purposes. From a point on the incoming water supply line, the Contractor shall extend water line for fire protection purposes to Siamese connections.

B. Wall type Siamese shall be equal to Potter-Roemer No. 5206-3-way or by W.D. Allen Company cast brass body and escutcheon. They shall have proper caps with pin

type lugs attached to the body of connection with substantial chains. "AUTOMATIC SPRINKLER" is to be cast on head of connection. All external surfaces shall be chromium plated polished surfaces or as directed by Architect.

PART 3 EXECUTION

3.01 PREPARATION - All systems:

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Flush entire system of foreign matter.

3.02 SYSTEM TESTS

A. Hydrostatically test entire standpipe system in accordance with NFPA 14 and sprinkler in accordance with NFPA 13.

B. Test shall be witnessed by campus Fire Marshal.

3.03 INSTALLATION

A. SPRINKLERS

1. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains. Note that the piping sizes indicated in the plans are the minimum acceptable. The Qualified Contractor shall provide proper sizes, materials and installation as required in the appropriate NFPA Standard.

2. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

3. Connection from branches to sprinkler heads may be made with a flexible stainless steel tube and reducer. The flexible tube bends by hand for instant placement of every sprinkler in the precise center of tile of a suspended ceiling. The sidewinder flexible stainless steel tubing shall be as manufactured by “GATEWAY TUBING” OR APPROVED EQUAL.

4. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

5. Provide drain valves at main shut-off valves, low points of piping and apparatus. Provide Fire Department test station, piped to drain.

6. Locate outside alarm gong on building wall as indicated.

7. Place pipe runs to minimize obstructions with other work.

8. Place piping in concealed spaces above finished ceilings.

9. Center heads in two directions in ceiling tile and provide piping offsets as required.

10. Apply paper cover to ensure concealed sprinkler head and cover plates do not receive field paint finish.

11. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle *at a maximum 4'0" in height*.

3.04 GENERAL FABRICATION OF PIPE:

A. See Section 23 20 00.

END OF SECTION

SECTION 220000 - PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 0100, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide complete operating plumbing piping systems including pipe, tube, fittings, and appurtenances as indicated and in compliance with these Specifications. The Work of this Section shall include, but not be limited to:

1. Securing and installing plumbing services for the building.
2. A complete domestic hot and cold water distribution system.
3. A complete natural gas distribution system.
4. A complete sanitary soil waste and vent system.
5. Miscellaneous plumbing equipment and specialties required for a complete plumbing system as specified.

B. Plumbing Services: Secure all plumbing services necessary for the project as required or shown on the Contract Drawings, including paying all required fees and charges. Work related to plumbing services maybe shown on Plumbing, Civil, Architectural or other drawings in the Contract Documents. Plumbing services include, but are not limited to:

1. Extending water service from main to building.
2. Securing sanitary sewer connection permit from the authority having jurisdiction.
3. Connecting or arranging for the connection of the sanitary lines(s) into the sanitary sewer in accordance with the authority having jurisdiction.
4. Installing all drainage systems with the proper slope as required by code.
5. Boring and jacking existing streets, sidewalks, etc., in city right-of-way as is necessary. (Where this stipulation cannot be met, it shall be the responsibility of the plumbing contractor to secure all necessary permits at his cost to do whatever is required to secure the service from the city or local authority, and make whatever repairs necessary after the service is secured.)
6. Connect new gas service from SJC site underground network pipes.

C. Coordination: The Division 23 Contractor shall be responsible for coordinating plumbing services and site utility work as shown on the Contract Drawings with the General Contractor to determine what work is included in the scope of the Division 23 Contractor.

D. Applications: Applications of piping systems include, but are not limited to, the systems as listed below:

SYSTEM	WORKING PRESSURE	OPERATING TEMPERATURES
Domestic Cold Water		
Low	150 psig	55°F to 80°F
Domestic Hot Water		
Low	150 psig	90°F to 120°F

Make-Up Water		
Low	150 psig	55°F to 80°F
Condensate Drainage	--	40°F to 60°F
Sanitary Drainage	--	--
Storm Drainage	--	--
Natural Gas	--	--

E. Basic Materials and Methods: Refer to Section 23 03 00 for additional plumbing piping system requirements.

F. Valves and Accessories: Refer to Section 22 10 00 for additional plumbing piping system components.

G. Vibration Isolation: Refer to Section 23 05 48, "Vibration Isolation", for piping system isolation.

H. Insulation: Refer to Section 23 07 00, "System Insulation", for piping system insulation.

1.3 QUALITY ASSURANCE:

A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe. Refer to Section 23 0300 for additional requirements.

B. UPC Listing: All materials, fixtures or devices used or entering into the construction of the plumbing system shall be listed for UPC or shall conform to Alternate Standards recognized as "equal" by the City Officials having jurisdiction.

C. Cast Iron Pipe Testing: All cast iron waste and vent pipe shall be 100% factory water pressure tested at 50 psig minimum pressure prior to application of the exterior coating. A certified factory test report shall be furnished to the Engineer with the pipe submittal.

D. Cast Iron Pipe Manufacturers: Cast iron pipe shall be as manufactured by Tyler Pipe or Charlotte Pipe or AB & I and shall bear the CI mark indicating compliance with the CISPI quality assurance and inspection program.

E. Grooved Systems: To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be of the same manufacturer as the grooved components.

1.4 SUBMITTALS:

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheets marked to clearly indicate all plumbing piping system materials.
2. Piping fabrication drawings for all main piping runs. Fabrication drawings shall include plan views and suitable elevations and shall include all accessories and equipment.
3. Additional items as required in Section 23 0100.
4. Grooved joint couplings and fittings shall be shown on drawings and product materials, and be specifically identified with the applicable Victaulic style or series number.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver components in factory-fabricated water resistant packaging, as applicable.

B. Handle components carefully to avoid damages to components, enclosures, and finish.

C. Store components in a clean, dry space, and protect from weather.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS:

A. General: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.

1. Steel Pipe: ASTM A53 or ASTM A106 black or hot-dipped galvanized as specified. Piping shall be domestically manufactured by one of the manufacturers listed in the latest edition of the American Petroleum Institute (API) approved manufacturers listing.
2. Copper Tube: ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.
3. Ductile Iron Pipe: ANSI A21.51, Class 350 with bell and spigot ends for push-on joints.
4. Cast Iron Soil Pipe: ASTM A74, most current edition.
5. Hubless Cast Iron Soil Pipe: CISPI 301, most current edition.
6. **Polyvinyl Chloride (PVC) Storm Pipe: Sewer main SDR 41 or SDR 26, ASTM D3034 with bell ends and pre-inserted gasket joints.**

2.2 PIPE/TUBE FITTINGS:

A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing regulations, industry standards, and where applicable, with pipe manufacturer's instructions for selections.

1. Cast Iron Flanged Fittings: ANSI B16.1, Class 125 or Class 250, black or galvanized as specified, including bolting and gasketing.
2. Cast Iron Threaded Fittings: ANSI B16.4 or ASTM A126, Class 125 or Class 250, black or galvanized as specified.
3. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.
4. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
5. Threaded Pipe Plugs: ANSI B16.14.
6. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections.
7. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
8. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
9. Cast Iron Drainage Fittings: ANSI B16.22 galvanized, recessed fittings with pitched threaded ends.
10. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2". Do not thread nipples full length (no all-thread nipples).
11. Wrought Copper/Bronze Solder-joint Fittings: ANSI B16.22 suitable for working pressure up to 250 psig.
12. Hubless Cast Iron Pipe Fittings: CISPI 301, most current edition, and comply with governing regulations.
13. Cast Iron Soil Pipe Fittings: ASTM A74, most current edition.
14. Compression Gaskets: ASTM C1563 for gasket testing and ASTM C564 for elastomeric compound.

15. Lead/Oakum Joint Materials: Sealite white oakum and pure pig caulking lead.
16. Standard Grooved End Fittings: ASTM A234 forged steel or ASTM A53 fabricated carbon steel, or ASTM A536 ductile iron fittings joined with Victaulic Style 77 or Style 07 couplings and Grade "E" gaskets on steel systems. **On copper systems, ASTM B-75 alloy C12200 or sand casting B-584-87 alloy CDA 844 (81-3-7-9) with Style 606 coupling.**
17. Flanged Fittings: Comply with ANSI B16.15 for bolt-hole dimensioning, materials, and flange-thickness.
18. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
19. Flange Bolt Thread Lubricant: Lubricant shall be an antiseize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
20. Mechanical Joints for Cast Iron and Ductile Iron Pipe: AWWA/ANSI 21.11 with appropriate gaskets, nuts and bolts.

B. Miscellaneous Piping Materials/Products:

1. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.
2. Brazing Materials: American Welding Society, AWS A5.B, Classification BCup-5.
3. Gaskets for Flanged Joints: 1/16" thick for all pipe size 10" and smaller and 1/8" thick for all pipe size 12" and larger. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed nonasbestos or equal.
4. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Clearflow" waterway as made by Victaulic, "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation.
5. Gaskets for Cast Iron Soil Pipe: ASTM C564, neoprene, compression-type.
6. Push-on-joints: ANSI A21.11, rubber compression-type, "Tyton Joint" as manufactured by U.S. Pipe or equal.
7. Hubless Cast Iron Joints: Heavy duty couplings: Clamp all 125, Husky SD4000 or MG.
8. Solder: All solder used for sweating of water **and laboratory air and vacuum** piping joints shall be 95/5 tin-antimony or tin-silver. All solder used for sweating of natural gas piping joints shall be phosphorous-free, non-lead bearing silver brazing solder with a melting point in excess of 1000°F.
9. Threadsealing Tape: Threadsealing tape used for plumbing piping applications shall be stretched or nonstretched teflon tape. Threadsealing tape used for natural gas piping applications shall be nonstretched 0.004" thick teflon tape and shall be yellow in color for identification.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION:

A. General:

1. Industry Practices: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections,

within 1/16" misalignment tolerance. Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by the Engineer.

2. Systems: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms. Where pipes of different sizes join, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.
3. Expansion and Contraction: Install loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment.
   a. Expansion Loops and Offsets: Provide expansion loops and offsets in piping systems for not less than one inch (1") expansion or contraction per 100'of pipe. Use Victaulic style 75 or 77 flexible type couplings on expansion loops in accordance with the latest Victauliv recommendations for expansion compensation.
   b. Mechanical Grooved Couplings: Provide mechanical grooved connections equal to Victaulic style 75 or 77 where indicated on the Drawings and Specifications to reduce vibration at equipment connections. Provide expansion joints in piping systems by mechanical grooved connections where specifically indicated on the Drawings. Expansion joints shall be of one of the following types:

      1. Packless, gasketed slip-type expansion joint grooved end telescoping body for installation with Victaulic style 07 rigid type couplings, providing axial end movent up to 3”. Victaulic style 150 Mover.
      2. combination of Victaulic style 77 or 75 flexible type couplings and short nipples joined in tandem for increased expansion. Joined movement and expansion capabilities determined by the number and style of couplings/nipples used in the joint. Victaulic seris 155.
4. Pipe Grading: Install domestic water piping to pitch down in the direction of flow for drainage. Grade storm, soil, and waste piping at 1/4" per foot whenever possible, and not in any case less than 1/8" per foot for pipe sizes 4" and larger, unless shown otherwise on the Drawings. Grade vent piping at 1/4" per foot whenever possible, and not in any case less than 1/8" per foot toward vents. Grade gas piping at a minimum of 1/8" per foot toward condensation traps at connected equipment.

B. Steel Pipe: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up. Use John Crane or approved equal teflon thread tape applied only to male threads to make-up joints.

C. Copper Pipe: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth, No. 00 cleaning pads or wire brush. No acids shall be used to clean either pipe or fittings or as a flux in sweating joints. The use of drilled T connections is not permitted.

D. PVC Pipe: Cut PVC pipe square and remove all burrs. Clean fitting and pipe butt prior to installation. Install all PVC piping in accordance with the manufacturer's recommendations.]Underground installation of PVC piping shall be in compliance with ASTM D2321.

E. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where Drawings show equipment to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of chilled water, hot water, condenser water, gas, domestic water, waste, and vent as shown. Provide valves, unions, strainers, check valves, and traps as required for proper operation of

systems and equipment. Equipment not shown or noted on the piping drawings shall not be included in the scope of this requirement.

F. Excavation, Installation, and Backfill for Underground Pipe:

1. Layout: Pipes shall be laid and pipe joints made in presence of the Owner's Representative and field measurements, layouts, batter board alignment, grade establishments, and similar locations shall be performed by a Professional Engineer in the employ of the Contractor. The Contractor's engineer shall be on the job during all underground work. A "Bench-Mark" reference for use by the Contractor shall be provided by the Owner.
2. Pipe Grading: Lay and maintain all pipes at required lines and grades during the course of the Work to comply with the Drawings.
3. Trench: Excavate the trench to the depth required. Properly brace and dewater the trench and keep it free of water during installation, testing pipe, and backfilling. No water shall be discharged onto a street or freeway without approval by the Architect. Refer to Section 23 0100 for additional requirements.
4. Excavation: The trench shall be at least 18" wider than the maximum diameter of the pipe or largest bell and the pipe shall be laid in the center of the trench. The trench shall be excavated to a depth sufficient to provide for pipe cushions or supports as specified with a minimum backfill cover of 30". Trench width may be increased as required and piling left in place until sufficient compacted backfill is in place. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc. The quantity of excavation required to install sheeting and the installation and removal of sheetings and bracings will not be regarded as Extra Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price. Refer to Section 23 0300 for additional requirements.
5. Grading: Upon completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion, except where the cushion has been eliminated by the Engineer. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion shall be as follows:
    a. Stable, Firm Semidry Trench: Piping shall be laid on undisturbed earth, in a constant uniformly sloped trench. Laying space for hubs or mechanical joints shall be hand cut to 6" either side of the joint and stabilized sand poured and wet in to even with the natural earth trench bottom. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test being performed again. Where the slope of the trench is found to belly down along the line of piping, before joining, the pipe shall be removed from the trench and the belly converted to uniform slope by adding stabilized bank sand, wet down and slightly mounded to the center of the trench. The section of piping will then be "rolled" into place so with support uniform along its entire length. Where the slope of the trench is found to arch up along the line of piping, before joining, the pipe shall be removed from the trench and the arch converted to uniform slope by cutting the arch out. The section of piping will then be reset into place with support uniform along its entire length.
    b. Wet Clay - Black Gumbo: Piping shall be laid in a constant, uniformly sloped trench. After shaping, the trench shall receive 3" minimum clean bedding sand, which shall be uniformly distributed on the trench bottom. Laying space for the hubs or mechanical joints shall then be hand removed and the piping placed on the setting bed with the weight of the piping distributed evenly on the setting bed over its entire length. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping by the Engineer's agent. Failure to notify

the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test performed again.

c. Rock: Where rock is encountered, the trench shall be excavated to a minimum of 6" below the pipe elevation and then backfilled with bedding sand to provide a uniform layer for pipe support. Backfill shall be as indicated for Wet Clay - Black Gumbo.

d. Special Considerations: Where there are expansive soil conditions on the site, special precautions shall be taken to prevent pushing and breakage of underground piping. Precautions shall be in accordance with local installation techniques and may include carton forms or special pipe bedding.

6. Anchors: Cast iron pipes shall have concrete anchors at each change in direction and/or as directed. Any change in direction exceeding 15 degrees shall be anchored. Concrete anchors shall rest against **solid (virgin) ground** with the required area of bearing on pipe and ground to provide suitable anchoring.

7. Backfill: Backfill trenches only after piping has been inspected, tested, and approved by the Architect. Place backfill material in the trench either by hand or approved mechanical methods. The compaction of backfill material shall be accompanied by tamping with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect. Backfill completely around pipe, including 18" above the pipe, with suitable bank sand, tamped in 4" layers under, around, and over pipe. Water down backfill as required. The remainder of the backfill for pipes shall be select backfill material tamped at intervals of no more than 12" depths, to attain a 95% Proctor Compaction Density. All materials to be used as select material backfill shall be approved by the Architect. If, in the opinion of the Architect, the excavated material does not meet the requirements of select material, the Contractor shall be required to screen the material prior to its use as select material backfill. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than 6" in its longest dimension. No wood, vegetable matter, or other material, which in the opinion of the Architect is unsuitable, shall be included in the backfill. The upper 24" of backfill may be water jetted, if desired. Bring backfill up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation. When removal of unsuitable, excavated material creates a shortage of backfill material, the Contractor shall, at no change in Contract amount, furnish material as specified in this Section in the amount required to complete the backfill.

8. Existing Surfaces: Restore existing streets, driveways, and sidewalks damaged during the excavation work to acceptable condition, subject to approval by the Architect.

9. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the City. Refer to Section 23 0300 and Division 1 for additional requirements.

G. Pipe Fabrication Drawings:

1. Pipe fabrication drawings shall be submitted for all piping in the Central Plant, Mechanical Rooms, Penthouse and for Equipment connections and all other areas requiring coordination with other trades.

2. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, support requirements, pipe elevations and other information required for coordination with other trades and fabrication of pipings.

3. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 23 01 00 for additional shop drawing requirements.

H. Basic Materials and Methods: Refer to Section 23 03 00 for additional requirements related to plumbing piping.

3.2 PLUMBING SERVICES:

A. General: Install the various piping systems as described and as required by the local plumbing inspection department.

1. Slope domestic hot and cold water piping to drain and provide with hose valves (drain valves) at low points.
2. Install soil, waste, and vent piping with horizontal lines pitched in accordance with local codes, but in no case less than 1/4" per foot for pipe 3" and smaller and 1/8" per foot for pipe 4" and larger. Install soil, waste, and vent piping with hubs of each length of piping in the upstream position.
3. Make-up lead and oakum joints with molten lead run into hubs in one continuous pour, to a minimum depth of one inch (1").
4. Make-up "Ty-Seal" or "Dual-Tite" gasketed joints using lubrication and joining tools as instructed by the manufacturers. Base of stacks, horizontal runs under pressure, and gasketed pipe 5" and larger shall be made up using "Tyler Lubrifast" joining material. Horizontal joints, 5” and larger, shall be restrained.
5. Torque "No-Hub" joints in accordance with manufacturer's instructions. Do not install "No-Hub" joints below ground.
6. Provide chrome-plated piping at each fixture installed in a finished space. Install with proper strap wrenches to avoid marking or defacing.
7. Provide proper restraints on riser and stack offsets.

3.3 DOMESTIC HOT AND COLD WATER PIPING SYSTEMS:

A. Interior Hot and Cold-Water Piping:

1. Type "L" copper tubing hard drawn joined using non-lead bearing solder, such as 95-5 silver or antimony solder (95% tin and 5% silver or antimony).
2. Domestic hot and cold water piping may utilize Pro-Press fittings on run-outs from the main when pipe is 1 ½” or less. The risers and the main located above the duct in the hallway shall be soldered.
3. Provide isolation fitting whenever dissimilar materials are used.

B. Piping Runouts to Fixtures: Provide piping runouts to fixtures sized to comply with governing regulations. Where not otherwise indicated, provide runouts sized to comply with the following: lavatories - 1/2" hot, 1/2" cold; water closet flush valves - one and one half inch (1-1/2") cold; urinal flush valves - one inch (1") cold; drinking fountains - 1/2" cold. Provide each fixture with a shut-off valve for each supply line. All exposed lines shall be chromium-plated.

C. Air Chambers:

1. Riser Air Chambers: At the top of each main hot and cold water riser, provide [a properly sized Wade Shoktrol or approved equal sealed air chamber] [an air chamber two pipe sizes larger than riser pipe and 24" high].
2. Fixture Air Chambers: At each hot and cold water supply pipe at each fixture, provide [a properly sized Wade Shoktrol or approved equal sealed air chamber,an air chamber the same size as the fixture branch and not less than 18" high.

3.4 UNDERGROUND DOMESTIC WATER PIPING:

A. Service Piping Two Inches and Smaller: Type "K", copper tubing with wrought copper brazed end fittings.

B. Underslab Piping: Piping under the building slab for hose bibbs and equipment stubs shall be no larger than one inch (1") and shall be Type "K" soft drawn copper tubing. Piping shall be run continuous from slab penetration to penetration and there shall not be any fittings or connections below the slab. Piping shall have minimum 12" cover in nonpaved areas. Underground piping up to 3" above slab penetrations shall be protected as described herein below.

C. Water service piping shall not be installed under concrete slabs on grade.

3.5 SANITARY DRAINAGE SYSTEM:

A. Waste and Vent Piping Underground: All underground waste and vent piping, including turns to the vertical to 12" above the grade floor slab, shall be constructed of schedule 40 PVC pipe and fittings with solvent weld pipe conforming to ASTM 1785.. Pour concrete thrust blocks at all below grade turns and offsets for waste piping 6" and larger.

B. Vertical Waste and Vent Piping Above Grade: Same as underground except when it's routed through a return air plenum must be insulated with fire wrapped material.

C. Insulation: All condensate drains and related piping, roof drain and overflow roof drain bodies and horizontal runs of storm drainage piping within the occupied spaces of the building, shall be insulated as specified in Section 23 0700.

D. Cleanouts:

1. Locations:
   a. Upper terminal of each horizontal drainage pipe.
   b. Each 90'length of horizontal straight run of drainage piping on the exterior, each 50' length of horizontal straight run of drainage piping in the interior.
   c. Where shown on Drawings.
   d. As required by local code.
2. Size: Cleanouts shall be line size for piping up to 4" and 4" size for piping larger than 4".
3. Access: Provide access doors for access to cleanouts installed in concealed locations.

E. Fixture Connections:

1. Water Closets: Galvanized castable nipples.
2. Lavatories: Copper or cast-iron nipples with suitable adapters.
3. Service Sinks: Brass or cast-iron nipples with suitable adapters.
4. Drinking Fountains: Copper or cast-iron nipples with suitable adapters.

3.6 NATURAL GAS PIPING SYSTEM:

A. Code Compliance Products: Comply with local utility company and AGA regulations which require the products used for gas piping work to be selected from lists in certain published standards or coded as indicated.

B. Gas Piping: Gas piping intended for operation at pressures of 5 psig inside building shall be ASTM A53, Schedule 40, black steel joined by Schedule 40, black welding fittings. Gas piping, 2-1/2" and smaller, intended for operation at pressures less than 5 psig shall be ASTM A53, Schedule 40, black steel joined by Class 150 socket weld fittings except that Class 150, banded, black malleable iron, threaded fittings maybe used at valves and equipment connection and downstream of room isolation valves. Provide condensation traps with removable caps at all equipment connections.

C. Concealed Piping and Protection: Gas piping run concealed in walls, chases, or above return plenum accessible ceilings shall be installed in a Schedule 20 welded steel sleeve vented to the outside atmosphere. Suitable internal spacers shall be provided. Gas piping shall run exposed below ceiling in laboratories floors. Inaccessible piping shall be all-welded connections. Socket type weld fittings may be used for sleeved gas piping.

D. Gas Distribution System Drip Pipes: Drip pipes shall be provided throughout the gas piping systems for the purpose of accumulating moisture and condensate. They shall be sized no smaller than the gas main which they drain in each instance.

E. Gas Distribution System Fabrication Methods:

1. All interior gas piping shall, wherever possible, be installed so as to grade back toward the gas entry. In all cases where such grading is impracticable and it is necessary to grade the house piping away from the inlet, drip pipes of adequate capacity must be installed where

traps are formed by such changes in grade. Drip pipes shall terminate a screwed pattern, malleable iron black cap. No drip pipes shall be used as outlets for the attachment of any fixture or gas appliance. Drip pipes must, moreover, be placed at the bottom of all vertical pipes which rise from and connect to the end of any horizontal pipe.

2. All branch outlet pipes shall be taken from the top or sides of running horizontal lines and not from the bottom. No crosses shall be installed in any horizontal gas line. No unions, gas cocks, or valves shall be used in any concealed location. Every gas cock and valve shall be accessible for inspection and repair.
3. The general arrangement of all gas piping shall be such that the number of threaded joints involved is reduced to an absolute minimum. If obstructions are encountered, pipe shall not be bent to circumvent such obstructions. Welding fittings shall be used for this purpose in the case of welded lines, and if threaded lines are involved, screwed fittings shall be used. Wherever gas pipes run through outside brick, stone, or other walls, the opening around the pipe shall be securely and rigidly sealed. Gas pipe sizes shall be at least one pipe size larger than the inlet of the gas appliance which they supply. No bushings shall be used in conjunction with any gas piping.

F. Gas Distribution System Protective Coating: Gas piping systems installed underground shall utilize pipe which has been factory coated with Scotchkote protective resin No. 212. All materials, surface preparation, application and testing shall conform to Federal Specification L-C-530 B-Type 2. This coating shall be applied by A&A Coating Company, Lone Star, Texas. Underground welded joints and fittings shall be coated with Scotchkote No. 306 epoxy resin and taped with vinyl Scotchwrap-50 brand tape. Flanged joints shall be given two coats of Koppers Company No. 300M Catalyzed Coal Tar Epoxy. Under no circumstances shall any backfilling operations be begun until these pipe protection operations have been completed.

3.7 CONDENSATE DRAINAGE:

A. General: Provide a condensate drain pipe to connect each cooling unit drain pan and secondary drain pan to extend to and discharge into an open-type drain in the plumbing system.

B. Assembly: Use Schedule 40, galvanized steel pipe made up with Class 125, galvanized, threaded fittings. Assemble fittings to form a trap with depth equal to or greater than operating pressure of the unit served. Drains shall be of the sizes indicated, but not less than the full size of the drain pan connection. Air handling unit drains shall have deep seal traps to permit unit pan drainage. Install a deep seal trap for each blow-through or draw-through air handling unit to maintain the water seal.

3.8 CHASE AND WALL PIPING SUPPORTS:

A. All piping whether sanitary or water shall be rigidly installed in all chases or walls. Test for rigidity shall be that the piping is virtually immovable by hand short of deforming the piping. Valve, stop and fixture penetrations thru chase or fixture mounting walls shall be firmly supported from just inside the wall or chase prior to penetration to the room-side of the chase or wall.

B. Support inside the chase or wall for Sanitary Waste and Vent Piping shall be accomplished by utilizing fixture carrier bolt-downs, "Uni-Strut" or similar structural bracing system, "U-bolts", nuts and lock-washers, all bolted to the floor and to the piping system.

C. Support for Water Piping or other similar service piping shall be accomplished by using a "system" designed for that purpose. An approved system shall consist of preformed steel supports which shall be installed between studs or joists and preformed nonmetallic pipe holder inserts which are designed to rigidly support or hold the piping to the steel supports.

D. In no case shall Sanitary Sewer Waste or Vent Piping depend on blocks, brick, stone or wood sleepers for its final support. In no case shall Water Piping or similar service piping depend on its final support on "tie-wires", soldering or brazing to metal studs or joists, copper tube soldered to risers and tied to joists or any other method which does not have the written approval of the Engineer. Piping improperly supported shall have improper supports promptly removed and replaced with specified supports at the direction of the Engineer at no additional cost to the Owner and/or Architect/Engineer.

E. The support system shall be as manufactured by "Holdrite" or an approved equal.

3.9 CLEANING, FLUSHING, TESTING AND INSPECTING:

A. Cleaning: Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.

B. Piping Tests:

1. General: Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by the Engineer or Owner's Representative and local inspectors and results presented to the Engineer for acceptance and approval prior to concealing piping from view. Provide all necessary equipment for testing, including pumps and gauges. Refer to Section 15020 for additional requirements.
2. Domestic Water Systems: Test hot and cold water systems hydrostatically to a pressure of 150 psig or 1-1/2 times working pressure, whichever is greater, for a period of 24 hours. Repair all leaks, replacing materials as necessary and repeat tests until systems are proven tight.
3. Soil, Waste and Vent Piping System: Test soil, waste, and vent piping by plugging all openings and filling system to height required by UH Plumbing Inspector, but not less than 10'above the level of the pipe being tested, for a minimum of 3 hours. Inspect all joints for leaks, repair all leaks found, and retest until piping is demonstrated to be free from leaks as evidenced by no perceptible lowering of the water level after 3 hours. In addition to water test, apply peppermint or smoke tests, if required by local code.
4. Natural Gas Piping System: Test natural gas piping with compressed air or nitrogen to a pressure of five times the expected service pressure, but not less than 100 psig, for a period of 24 hours. Repair all leaks, replacing materials as necessary, and repeat test until systems are proven absolutely tight. After all pneumatic testing of the entire gas piping system has been completed and all leaks have been repaired and at a time deemed suitable by the Owner's duly authorized representative, the Contractor shall have the gas supply turned on and the gas odorant chemical added by a representative of the gas company, as applicable. The Contractor shall then bleed gas from every riser and every runout until the odor of gas is present at every gas connection.
5. Flushing: Flush water piping systems with clean water following successful testing. Refer to Section 15100 for additional pipe cleaning and flushing requirements.

C. Disinfection of Water Systems: Disinfect hot and cold water systems as follows: Fill systems with water solution containing 50 ppm available chlorine; allow to stand for 8 hours, opening and closing all valves several times during this period; thoroughly flush; refill and place system in service; ensure a residual chlorine content of 0.2 ppm. Refer to Section 23 0300 for additional requirements.

D. Cleaning and Adjusting: Thoroughly clean and disinfect all plumbing fixtures, including all exposed trim. Adjust all flush valves for proper flushing, but without excess use of water. Demonstrate to the Engineer that the entire plumbing system and all its components are functioning properly.

E. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories and appurtenances.

F. Grooved Piping Installation: Grooved joint piping systems shall be installed in accordance with the manufacturer’s (Victaulic) guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by Victaulic. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training to contractor’s field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.10 IDENTIFICATION:

A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 22 00 00

SECTION 221010 - PLUMBING PIPING VALVES AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 0100, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide plumbing piping valves and accessories as specified, and indicated.

B. Types: The types of plumbing piping valves and accessories required for the project include, but are not limited to:

1. Valves.
2. Strainers.
3. Unions.
4. Flanges.
5. Gaskets.
6. Flexible connections.
7. Gauges.

1.3 QUALITY ASSURANCE:

A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable, subject to compliance with the requirements of these Specifications.

1. General Valves:
   a. Crane Company.
   b. Jenkins Bros. Valves.
   c. Lunkenheimer.
   d. Nibco.
   e. Red and White.
   f. Stockham Valves and Fittings.
   g. Walworth Company.
   h. Flomatic valves.
   i. KITZ.
2. Ball Valves:
   a. Apollo.
   b. Crane Company.
   c. Jenkins Bros. Valves.
   d. Nibco.
   e. Red and White.
   f. Stockham Valves and Fittings.
   g. Victaulic.
   h. KITZ.
3. Backflow Preventers/Pressure Reducing Valves:
   a. Febco.
   b. Hersey Products, Inc.

c. Watts Regulator Company.
d. Flomatic valves.

4. Check Valves:
   a. Crane Company.
   b. Jenkins Bros. Valves.
   c. Mission.
   d. Muesco, Inc.
   e. Williams-Hager, Clow Pipeline Products, Valve Division.
   f. Victaulic.
   g. Flomatic valves.
   h. KITZ.
5. Strainers:
   a. Crane.
   b. Keckley.
   c. Muessco.
   d. Victaulic.
   e. Zurn.
   f. KITZ.
6. Thermostatic Mixing Valves:
   a. Leonard.
   b. Rada.
   c. Lawler.

1.4 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets on all valves, strainers, unions, flanges, gaskets, water meters, and gauges and thermometers, clearly showing all rating, capacities, and features.
   2. Valve samples, when requested.
   3. Additional information as required in Section 23 0100.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Store plumbing piping valves and accessories in their factory-furnished coverings, and in a clean, dry indoor space which provided protection against the weather.

PART 2 - PRODUCTS

2.1 VALVES:

A. General: All valves shall be similar to numbers listed. All similar type and size valves shall be products of one manufacturer.

B. Applications: Valve application shall be as follows:

Service	Application	Type
Domestic Water	Shutoff	Ball
Industrial Water	Shutoff	Gate
	Balancing	Globe
	Check	Silent Check

C. Pressure Ratings:

Service	Location	Rating

Domestic Water	All	Refer to Section 22 00 00

D. Gas Valves

1. General: All valves shall be designed, manufactured and approved for natural gas service.

2. Line Shut-off Valves sizes 2 inches and smaller shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, wrench operation, rated for 200 WOG service pressure and –20 to 200 degrees F., manufactured by Resun Model R-1430 or Nordstrom Model 142.
3. Line Shut-off Valves sizes 2½ inches and larger shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with flanged ends, wrench operation, rated for 200 WOG service pressure and –20 to 200 degrees F., manufactured by Resun Model R-1431 or Nordstrom Model 143.
4. Appliance/Equipment Shut-off Valves at local connections sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL or Milwaukee Model BB2-100.
5. Manual Emergency Shut-off Valves sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL or Milwaukee Model BB2-100.

E. Insulated Piping: Stems on all valves installed in insulated piping shall be extended to allow adequate clearance between the operator and the insulation specified for the piping system when the valve is installed.

F. Flanges: Valve flanges and companion flanges for all valve applications shall be compatible with the valve rating and the system pressure at the point of application. Flanges shall conform to ANSI B16.1 and ANSI B16.10.

G. General Requirements:

1. All valves shall be of threaded or flanged type. No solder connected valves on water lines shall be used on this project. All bronze and iron body gate and globe valves shall be of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
2. All valves at system points where the System Working Pressure (SWP) at the point of application, including appropriate pump shutoff head, does not exceed 150 psi, may use Class 150 valves.
3. All bronze gate valves for pressures up to 150 psi shall be ASTM B62 composition bronze. Bronze valves for pressures above 150 psi shall be ASTM B61 steam bronze. All bronze valves shall be union or screw over bonnet, rising stem type with ASTM B99 alloy 651 or ASTM B371 alloy 694 or equal stem material.
4. All bronze ball valves for pressures up to 300 psi shall be ASTM B62 composition bronze or ASTM B584 alloy 844.
5. All iron body valves shall have the pressure containing parts constructed of ASTM A126 Class B cast iron. Stem material shall meet ASTM alloy 876 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting shall be provided on yoke cap for maintenance lubrication of the yoke bushing.
6. All valves shall be repackable, under pressure, with the valve in the full open position.

7. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron handwheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A126 Class B, gray iron handwheels.
8. Packing for all valves shall be selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked at no expense to the Owner with a packing material selected by the Owner.
9. Valves located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 at Boss G to accommodate a drain valve.

H. Plumbing Valves For Domestic Water Service at or Less Than 150 PSIG:

1. Ball Valves:
   a. Ball valves shall be two piece with a standard or full line size port chromium plated brass balls for domestic water, 316L stainless steel and stems and reinforced seats and stuffing box rings. All ball valves shall be designed to permit repacking while valve is in line. Valves shall be furnished with blowoutproof stems.
   b. Ball valves 2" and smaller shall be threaded body bronze or brass valves of a **full or standard** port design. Valves shall be rated for 300 psi WOG and shall conform to Federal Specification WW-V-35B. Valves shall be:
      1) Apollo No. 77-100 Series.
      2) Crane No. 9032 Series .
      3) Nibco No. T-585 Series.
      4) Red and White No. 5044F Series.
      5) Stockham No. S-216-BR-R-T.
      6) Victaulic Style 722 .
2. Gate Valves:
   a. Valves 2-1/2" and larger shall be flanged bronze mounted Class 125 iron body, outside screw and yoke gate valves with bolted bonnets and solid wedges. Valves shall be rated for 200 psi WOG and shall conform to MSS SP-70 and shall be:
      1) Crane No. 465-1/2.
      2) Jenkins No. 651-C.
      3) Lunkenheimer No. 1430.
      4) Nibco No. F-617-0.
      5) Red and White No. 421.
      6) Stockham No. G-623.
      7) Walworth No. 8726-F.
3. Globe Valves:
   a. Globe valves 2" and smaller shall be 300 psi WOG rated, all bronze globe valves with renewable-regrindable stainless steel plug disk and seat ring, union bonnet, and threaded connections. Valves shall conform to MSS SP-70 and shall be:
      1) Crane No. 14-1/2-P.
      2) Jenkins No. 546-P.
      3) Lunkenheimer No. LQ-600-150.
      4) Nibco No. T-276-AP.
      5) Stockham No. B 29.
      6) Walworth No. 3237-P.

b. Angle and Y-pattern globe valves corresponding to the standard globe valve models specified above may be used where more-suited to the installation location.

c. Valves 2-1/2" and larger shall be flanged bronze mounted Class 125 iron body, outside screw and yoke globe valves with bolted bonnets and renewable seat and disc. Valves shall be rated for 200 psi WOG and shall conform to MSS SP-85 and shall be:

1) Crane No. 351.
2) Jenkins No. 613-B.
3) Lunkenheimer No. 1123.
4) Nibco No. F-718-B.
5) Red and White No. 400.
6) Stockham No. G-512.
7) Walworth No. 8906-F.

4. Check Valves:

a. Check valves 2" and smaller shall be Class 150 threaded bronze swing check valves with horizontal swing and replaceable discs. Valves shall be rated for 300 psi WOG and shall conform to MSS SP-80 and shall be:

1) Crane No. 141.
2) Jenkins No. 352-C.
3) Lunkenheimer No. 230.
4) Nibco No. T-433.
5) Red and White No. 238.
6) Stockham No. B-321.

b. Check valves 2-1/2" and larger shall be flanged bronze mounted Class 150 iron body swing check valves with bolted bonnets and renewable seat and disc. Valves shall be rated for 200 psi WOG and shall conform to MSS SP-71, Type 1 and shall be:

1) Crane No. 373.
2) Jenkins No. 624-C.
3) Lunkenheimer No. 1790.
4) Nibco No. F-918-B.
5) Red and White No. 435.
6) Stockham No. G-931.
7) Walworth No. 8928-F.

c. All swing check valves shall be installed in horizontal piping only. Allow adequate pipe clearance to allow for proper valve operation.

I. Reduced Pressure Backflow Preventer: Backflow preventers up to 2" shall be bronze body, lead free, reduced pressure principal type with strainer and inlet and outlet gate valves, Clayton Model RP-2 or an approved equal. Backflow preventers 2-1/2" and larger shall be all bronze or epoxy coated cast iron with strainer and inlet and outlet OS&Y gate valves, Clayton Model RP-1 or an approved equal.

J. Flanges: Valve flanges and companion flanges for all valve applications shall be compatible with the valve rating and the system pressure at the point of application.

2.2 STRAINERS:

A. General: Water strainers shall be as follows:

1. 150 psig Working Pressure: 150 psig working pressure, 2" and smaller, shall be Muessco No. 351 or equal, 200 pounds WOG, bronze body with perforated 20 mesh stainless steel screen with cleanout and screwed ends. 150 psig working pressure, 2-1/2 through 24", shall be Muessco No. 751 or equal, 150 pounds WOG, perforated stainless steel screen

with 1/16" perforations for sizes through 4", and 5/32" perforations for 5" and above, with blowdown connection, and Class 125 ANSI B16.1 flanged ends.

2. 300 psig Working Pressure: 300 psig working pressure, 2" and smaller, shall be Muessco No. 352 or equal, 400 pounds WOG, bronze body with perforated 20 mesh monel screen with cleanout and screwed ends. 300 psig working pressure, 2-1/2 to 24", shall be Muessco No. 752 or equal, 300 pounds WOG, perforated stainless steel screen with 1/16" perforations in sizes through 4", and 5/32" perforations for 5" and above, with blowdown connection, and Class 250 ANSI B16.5 flanges.

2.3 UNIONS:

A. General: Provide in lines assembled with screwed and soldered fittings at points of connection to items of equipment and elsewhere as indicated or required to permit proper connections to be made or so that equipment may be removed. Unions shall also be provided in welded lines at the connections to items of equipment, where flanges are not provided.

1. Unions in steel lines assembled with screwed fittings shall be malleable iron screwed pattern unions with bronze seats. Unions in copper or brass lines shall be all brass, threaded pattern unions. Where unions are required by the above in steel lines assembled by welding, they shall consist of two mating welding flanges.
2. Dielectric unions shall be used at all junctures of dissimilar metals.
3. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2-1/2" and larger shall be ground flange unions. Unions in copper lines shall be 125 pounds ground joint brass unions or 150 pounds brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

2.4 FLANGES:

A. General: All 125/150 pound and 250/300 pound ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or ASTM A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges will not be acceptable. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forgings or materials will not be acceptable. The flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Submit data for firm certifying compliance with these Specifications. Gaskets used shall be ring form, dimensioned to fit accurately within the bolt circle, shall be 1/16" thick, Manville service sheet packing Style 60. Inside diameter shall conform to the nominal pipe size. Bolts used shall be carbon steel bolts with semifinished hexagon nuts of American Standard Heavy dimensions. All-thread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, and similar items. Only one manufacturer of weld flanges will be approved for each project.

2.5 GASKETS:

A. General: Gaskets shall be placed between the flanges of all flange joints. Such gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick Manville Service Sheet Packing Style 60. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

2.6 FLEXIBLE CONNECTIONS:

A. General: Refer to Section 23 0548, "Vibration Isolation", for flexible connections.

2.7 GAUGES:

A. General: Provide gauges and thermometers for monitoring plumbing systems as shown on the Drawings and specified herein.

B. Gauges: Gauges shall be Ashcroft, Trerice, Weksler, Moeller, or U.S. with 4-1/2" dial face, phenol case, stainless steel movement with Grade A phosphor bronze bourdon tube and micrometer-type calibration adjustment screw. Accuracy shall be 1/2 of 1% of full scale. Provide a Crane No. 88 or equal needle valve gauge cock in pressure tube to gauge. Gradation shall be one pound or less.

C. Range and Gradations: Gauges and thermometers shall be selected to give range and graduations best suited for quantities to be measured. Generally, gauges and thermometers shall be selected so that normal operating pressures and temperatures are not more than 2/3 nor less than 1/2 of the range; scale division shall be 2°F or less. Typical ranges for domestic cold water shall be 0°F to 100°F and for domestic hot water shall be 30°F to 240°F.

D. Gauge Locations: Provide pressure gauges at the following locations:

1. Suction side of each pump.
2. Discharge side of each pump.
3. As shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Except as otherwise indicated, comply with the following requirements.

B. Isolation Valves: Provide isolation valves in domestic water systems at each runout to a piece of equipment, each fixture, and elsewhere as shown on the Drawings.

C. Valve Stems: Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane. All valves shall be located so as to make the removal of their bonnets possible. All flanged valves shown in the horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be made up with their valve stems inclined at an angle of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested for final acceptance. Valves shall be installed as nearly as possible in the locations as shown on and Drawings. Any change in valve location must be so indicated on the As-built Drawings.

D. Swing Check Valves: Swing check valves shall be installed in horizontal piping only.

E. Unions and Companion Flanges: Provide unions or companion flanges where required to facilitate dismantling of valves and equipment.

F. Strainer Blowdown: Provide a blowdown valve with hose connection and cap at each strainer for blowdown.

3.2 IDENTIFICATION:

A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 22 10 10

FAMILY SERVICES OF SOUTHEAST TEXAS
BEAUMONT, TEXAS

SECTION 223000 - FLOOR AND AREA DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 0100, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide floor, area, and roof drains, and drain specialties and cleanouts as specified.

B. Types: The types of drains and drain specialties required for this project include, but are not limited to:

1. Floor drains.
2. Floor sinks.
3. Cleanouts.
4. Hub drains.
5. Trap primers.

1.3 QUALITY ASSURANCE:

A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications:

1. J. R. Smith Manufacturing Company.
2. Wade Division/Tyler Pipe.
3. Zurn Industries, Inc.
4. Josam.
5. Watts Drainage.
6. Mifab.
7. Sioux Chief

1.4 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Cut sheets of drains and drain specialties clearly indicating all features, options, materials and dimensions.
2. Additional information as required in Section 23 0100.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver drains and drain specialties in factory-fabricated water-resistant wrapping.

B. Handle drains and drain specialties carefully to avoid damage to material component, enclosure and finish.

C. Store drains and drain specialties in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS:

A. General: Provide floor drains suitable for the type of construction and finishes at the point of application. Provide all drain accessories required for a complete installation, waterproofed where applicable.

B. Floor Drain:: Refer to P6.01 plumbing schedule for type.

C. Floor Sink:: Refer to P6.01 plumbing schedule for type.

2.2 CLEANOUTS:

A. General: Provide cleanouts as shown on the drawings and as required by local ordinance. The size of the cleanouts shall be identical with the size of the soil or waste line in which they are placed for 4" and smaller lines. The size of cleanouts in lines larger than 4" shall be 4" in all cases. Coordinate cleanout style, mounting, flange, and clamping ring with the construction and finishes where the cleanout is located. Floor cleanouts are to be chipped out per CRT's notes, refer to structural drawing S-301. Refer to Section 22 0000, "Plumbing Piping Systems", for additional requirements.

B. Cleanouts (C.O.) in Finished and Unfinished Floors: Adjustable coated cast iron body, brass or bronze countersunk plug, secured round nickel bronze top, Carpet marker for carpeted areas, flangeless, flanged or flanged with clamping ring as required; Zurn No. ZN-1400-VP-BP or Jay R. Smith No. 4033-U (flangeless), No. ZN-1400-KVP-BP or Jay R. Smith No. 4033-F-U(flanged) or No. ZN-1400-KC-VP-BP or Jay R. Smith No. 4033 – FC-U (flanged with clamping ring) or approved equal.

C. Cleanouts (C.O.) in Unfinished Floors: Coated cast iron cleanout ferrule with brass or bronze tapered thread cleanout plug and round smooth stainless steel cover plate; Zurn No. Z-1400-NH or Smith No. 4223 or approved equal.

D. Cleanouts (C.O.) in Finished Walls: Coated cast iron cleanout body with brass or bronze countersunk plug and square smooth nickel bronze cover plate and vandalproof securing screws; Zurn No. ZN-1443-VP-BP or Smith No. 4435-U or approved equal.

E. Cleanouts (C.O.) in Exterior Lines: Traffic duty, coated cast iron cleanout with brass or bronze tapered thread cleanout plug, nickel bronze top and vandalproof screws. Install in minimum 12" x 12" x 4" concrete pad where not in paving; Zurn No. ZN-1400-HD-VP or Smith No. 4103-U or approved equal.

2.3HUB DRAINS:

A. General: Hub drains (H.D.) shall consist of a cast iron soil pipe hub set 2" above floor, unless noted otherwise, and connected to a deep seal P-trap below the floor. Provide a trap primer where noted on the Drawings. Connect to equipment as required.

2.4TRAP PRIMERS:

A. General: Provide trap Guard primer inserts in all floor drains

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Installation: Coordinate flashing work with work of other trades and Architectural details. Coordinate with roofing as necessary to interface roof drains with roofing work.

B. Setting Locations: Install floor and roof drains in the low points of the surface areas to be drained. Set tops of drains flush with finished floor. Orient drain grates and cleanout covers to parallel floor tile lines where applicable.

C. Watertightness: Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing or flooring. Maintain watertight integrity of penetrated waterproof membranes.

D. Accessibility: Position drains so that installed drains are accessible and easy to maintain.

3.2 COORDINATION:

A. General: Coordinate the final location of all drains and cleanouts with the aesthetics of construction. Center drains in showers, and other finished spaces, align drains with tile grids and conceal cleanouts in inconspicuous areas.

B. Notification: Where a cleanout must be located in an exposed area or a drain location cannot be centered in a space or located in the location shown on the Architectural Drawings, notify the Engineer in writing prior to proceeding with the installation.

END OF SECTION 22 30 00

SECTION 224000 - PLUMBING FIXTURES

1.01 The following sections are to be included as if written herein:

A. Section 23 01 00 – Mechanical General Provisions

B. Section 23 03 00 – Sleeves, Flashings, Supports and Anchors

1.02 SECTION INCLUDES:

A. Lavatories

B. Sinks

C. Service Sinks

D. Water Closets

E. Faucets

F. Electric Water Coolers

G. Hose Bibbs

H. Thermostatic Mixing Valves

I. Vacuum Breaker

1.03 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 01 11 00 - Summary of Work: Owner furnished fixtures including.

B. Section 10 28 00 - Toilet and Bath Accessories.

1.04 RELATED SECTIONS

A. Section 06410 - Custom Casework: Preparation of Counters for Sinks

B. Section 06410 - Custom Casework: Lavatory Tops

C. Section 07 90 00 - Joint Sealers: Seal Fixtures to Walls and Floors

D. Section 23 03 00 - Supports and Anchors

E. Section 22 10 00 - Plumbing Piping

F. Section 22 10 10 – Plumbing Piping, Valves and Accessories

1.05 REFERENCES

A. ANSI/ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.

D. ANSI/ASME A112.19.2 - Vitreous China Plumbing Fixtures.

E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. ANSI/ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

G. ANSI/ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).

H. IAPMO/ANSI Z124.1 - Plastic Bathtub Units.

I. IAPMO/ANSI Z124.2 - Plastic Shower Receptors and Shower Stalls.

J. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

K. ANSI/ARI 1010 - Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers.

1.06 SUBMITTALS

A. Submit under provisions of Section 23 03 00.

B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Manufacturer's Installation Instructions.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 03 00.

B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 03 00.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.09 FIELD MEASUREMENTS

A. Verify that field measurements are either as indicated on shop drawings or as instructed by the manufacturer, and designate in the submittal both that it has been verified, and which measurements are the basis for construction.

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

1.10 WARRANTY

A. Provide five-year warranty under provisions of Section 23 03 00.

B. Warranty: Include coverage of electric water cooler compressor.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Section 23 03 00.

B. Provide two each of each type of faucet service kits, flush valve service kits.

PART 2 PRODUCTS

2.01 GENERAL

A. The Contractor shall provide plumbing fixtures where indicated on the Drawings. These plumbing fixtures shall be standard products as manufactured by Kohler, Crane, American Standard or Eljer. The fixtures shall be free from mars or chips and shall be new, first quality and shall be furnished with sufficient supports in order to adequately hang each and every unit. The space between fixtures and masonry walls shall be grouted with White General Electric Silicone flexible grout. The space between fixtures and sheetrock or wood panel walls shall not be grouted but the fixture shall fit flat against the wall surface with no more than 1/16" gap.

B. All faucets, fittings, supply stops and similar devices shall be of one manufacturer unless otherwise specified. All water faucets and valve bodies shall be cast brass with a minimum copper content of 85%. They shall contain standardized interchangeable operating units constructed of a removable and replaceable unit containing all parts subject to wear. All water faucets shall contain an adjustable internal volume control unit. All exposed parts shall be chromium plated.

C. All fixtures shall meet the requirements of ADA, ANSI A117.1, ANSI Z124.2 and the State of Texas Accessibility Standards (TAS).

D. See drawings for schedule of fixtures.

2.02 FITTINGS AND PIPES:

A. Fittings and piping shall be brass and, wherever exposed, shall be polished chrome-plated. Provide tight fitting wall or floor escutcheons of chrome-plated brass wherever pipes pass through floors, walls or ceilings.

B. Furnish and install all required water, waste, soil and vent connections to all plumbing fixtures, together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.

C. Supplies for all lavatories, sinks, tank type water closets and drinking fountains shall be loose key angle stops with 1/2" I.P.S. female inlets and shall include wall flanges, and 1/2" O.D. flexible risers with bull-nose or flared end outlets. All components to be chrome plated. In all cases, all piping, tubing, fittings, and faucets shall be installed using a mechanical non-slip connection, such as bull-nose, flared, flanged, ferrule, or threaded fittings. Fittings requiring a friction fit using slip-on or gasketed connections are not acceptable.

2.03 LAVATORIES - Handicapped - Lavatory Type (L-1):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

C. American Standard 7723.018, or McGuire 8088 with 1127 nipple grid drain, (or equal as manufactured by Crane, Kohler or Eljer) 1-1/4" inlet and 1-1/4" outlet adjustable cast brass P-traps with cleanout plug, brass threaded nipple from trap to tapped sanitary tee behind wall, chrome-plated cover tubing to wall and chrome plated wall escutcheon. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

2.04 LAVATORIES - Handicapped - Lavatory Type (L-2):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

C. American Standard 7723.018, or McGuire 8088 with 1127 nipple grid drain, (or equal as manufactured by Crane, Kohler or Eljer) 1-1/4" inlet and 1-1/4" outlet adjustable cast brass P-traps with clea,nout plug, brass threaded nipple from trap to tapped sanitary tee behind wall, chrome-plated cover tubing to wall and chrome plated wall escutcheon. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

2.05 SINK – Cosmetology General use - Type (SK-1):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

2.06 SINK – Stainless Steel Sink - Type (SK-2):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

C.

2.07 SINK – Stainless Steel Sink - Type (SK-3):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

2.08 SINK – Stainless Steel Sink - Type (SK-4):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

2.09 SINK – Stainless Steel Sink - Type (SK-5):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

B. Chicago Faucet 1006 supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets, wall flanges, and 12" long, 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Water Saver, Speakman, by approval only. Manufacturer must equal specification.

2.10 SHOWER – Shower Stall - Type (SH-1):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

2.11 SHOWER – Shower Stall - Type (SH-2):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

2.12 MOP SINKS - Jan. Closets - Mop Sink (MS-1):

A. Refer to plumbing fixture schedule on drawing P7.1 for type.

2.13 WATER CLOSETS (WC-1):

A. Refer to plumbing fixture schedules drawing P-701 for type.

2.11 WATER CLOSETS (WC-2):

A. Same as WC-1 but mounted at ADA height.

2.12 DRINKING FOUNTAIN (EDF-1):

2.12.1.1 Refer to plumbing fixture schedules drawing P7.1 for type.

2.12.1.2 P-trap as specified for lavatory.

2.13 HOSE BIBBS (HB-1):

2.13.1.1 Chicago Faucet 952/T&S Brass B-720 hose bibb, with vacuum breaker, 3/4" hose thread outlet, 3/4" flanged female inlet and removable tee handle with lock shield cap. Acceptable alternative manufacturers: Water Saver, by approval only. Manufacturer must equal specification.

2.14 WALL HYDRANT (WH-1):

B. Refer to plumbing fixture schedule on drawing P7.1 for type.

2.15 VACUUM BREAKERS:

2.15.1.1 All outlets with hose threads shall be provided with vacuum breakers. Where vacuum breakers have not been specified with fixture trim and on all hose faucets not associated with plumbing fixtures both inside and outside of buildings, contractor shall furnish and install 3/4" hose thread vacuum breakers attached to the hose outlet threads with tamper proof set screw. Vacuum breaker shall be as manufactured by Chicago Faucet (E-27 or E-22), or by Watts.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with or properly incidental to the installation of complete plumbing fixtures, as indicated on the Drawings, reasonably implied therefrom, or as specified herein, unless specifically excluded.

B. Plumbing fixtures shall be supplied, set and connected as listed herein and as shown on the Drawings. Fixtures shall be protected from damage during construction, and shall be thoroughly cleaned of all tape and adhesives prior to final acceptance.

C. Coordinate special mounting heights of plumbing fixtures with architectural details of each toilet area.

D. Install in accordance with manufacturer's instructions.

E. Install each fixture with trap, easily removable for servicing and cleaning.

F. Install components level and plumb.

G. Install and secure all fixtures in place with specified wall carriers and bolts.

H. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust work under provisions of Section 23 01 00.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Clean work under provisions of 23 01 00.

B. At completion clean plumbing fixtures and equipment.

3.07 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Section 23 01 00.

B. Do not permit use of fixtures during construction, until after Substantial Completion has been announced by Owner.

3.08 FIXTURE HEIGHTS

A. Fixture size, design and mounting height shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS).

B. Install fixtures to heights above finished floor as indicated.

C. Water-Closet

1. Standard 17 inches to top of bowl rim.

D. Lavatory (wall hung)

1. Standard 32 inches to top of basin rim.

E. Drinking Fountain

1. Standard 36 inches to top of basin rim.

3.09 FIXTURE ROUGH-IN SCHEDULE

	Hot Water	Cold Water	Waste	Vent
Lavatory:	1/2 inch	1/2 inch	1-1/2 inch	1-1/4 inch
Service Sink:	1/2 inch	1/2 inch	3 inch	2 inch
Sink:	1/2 inch	1/2 inch	1-1/2 inch	1-1/4 inch
Drinking Fountain:		1/2 inch	1-1/4 inch	1-1/4 inch
Water Closet:		1 inch	4 inch	2 inch

END OF SECTION

DIVISION 23 – MECHANICAL

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

Date: 12-30-2024
Engineer of Record: Heather Camden
State: Texas
License No.: 86883

THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY:

Digitally signed by Heather Camden, PE
Date: 2024.12.30 11:12:42-06'00'

E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

SECTION 23 0000
BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Basic Mechanical Requirements specifically applicable to Division 23 Sections, in addition to Division 01 - General Requirements.

1.2 RELATED DOCUMENTS:

A. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the Specifications apply to the work specified in this Section.

B. All work covered by this Section of these Specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.3 GENERAL:

A. The Contractor shall execute all work hereinafter specified or indicated on accompanying Drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.

C. The Mechanical, Electrical, and associated Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

D. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

1.4 LEED REQUIREMENTS

A. Each HISD Project is required to meet the U.S. Green Building Council’s “Leadership in Environmental and Energy Design or “LEED” requirements including the preparation of an Energy Performance Model. Provide coordination with the Commissioning Agent as specified in the Commissioning Documents.

1.5 BUILDING COMMISSIONING

A. Each HISD Project is required to meet the U.S. Green Building Council’s “Leadership in Environmental and Energy Design or “LEED” requirements including Enhanced Building Commissioning.

1.6 DEFINITIONS: (Note: These definitions are included here to clarify the direction and intention of this specification. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.)

A. CONCEALED / EXPOSED: Concealed areas are those areas which cannot be seen by the building occupants, such as inside chases. Exposed areas are all areas which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms and the space above the ceiling of the vivarium floors (catwalk space).

B. INTERIOR / EXTERIOR: Exterior spaces are considered to be all spaces that are exposed to ambient temperatures and relative humidities. Areas in the truck dock and unconditioned spaces in the central plant are to be considered "exterior".

C. General Requirements: The provisions of requirements of other Division 01 Sections apply to entire work of contract and, where so indicated, to other elements which are included in project. Basic contract definitions are included in the General Conditions.

D. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

E. Directed, requested, etc.: Where not otherwise explained, terms such as "directed", "requested", "authorized", "selected", "approved", "required", "accepted", and "permitted" mean directed by Architect/Engineer", "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

F. And/Or: Where "and/or" is used in these Specifications or on the Drawings, it shall mean "that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

G. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

H. As required: Where "as required" is used in these Specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

I. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations."

J. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

K. Install: The term "install" is used to describe operations at project site including "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operation."

L. Provide: The term "provide" means "to furnish and install, complete and ready for intended use."

1.7 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS:

A. General: Refer to Division 01 for construction phasing and time increments.

B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If City or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to City controlled services. If inspections by City personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these Specifications and Drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the Specifications and Drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.8 CONTRACT DOCUMENTS:

A. All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the Specifications, the Drawings, and the schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the Drawings or Specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.9 OWNER FURNISHED PRODUCTS

A. Products furnished to the site and paid for by Owner:

1.10 FUTURE WORK

A. Provide for future work under requirements of Section 01 1100.

B. The project is designed to be able to build out the shelled spaces. Do not block ductwork, piping, or electrical services for any of the future and shelled spaces. If there is a question about what is intended for the future spaces, submit the question in RFI form before blocking any risers, windows, etc.

1.11 ALLOWANCES

A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.12 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.

C. Any Alternate Proposals are summarized in Division 01 of the Specifications. The Contractor is directed to refer to all Sections of the Specifications and Drawings for this project to determine the exact extent and scope of the various Alternate Proposals as each pertains to the work of all trades.

1.13 SUBMITTALS

A. Refer to Uniform General Conditions.

B. Proposed Products List: Include Products specified in the following Sections:

1. Section 23 0513 - Motors
2. Section 23 0529 - Sleeves, Flashings, Supports and Anchors
3. Section 21 0548 - Vibration Isolation
4. Section 23 0553 - Mechanical Identification
5. Section 23 0593 – Testing, Adjusting and Balancing (TAB)
6. Section 23 0594 – Testing Adjusting and Balancing (Contractor Responsibilities)
7. Section 23 0713 - Ductwork Insulation
8. Section 23 0716 - Equipment Insulation
9. Section 23 0719 - Piping Insulation
10. Section 23 0923 - Direct Digital Control Systems
11. Section 23 0963 – Space Pressurization Tracking System
12. Section 23 0993 – Sequence of Operation
13. Section 23 2000 - HVAC Pumps
14. Section 23 2100 - Piping Valves and Fittings
15. Section 23 2113 - Hydronic Piping
16. Section 23 2123 - Hydronic Specialties
17. Section 23 2500 – Water Treatment Systems
18. Section 23 2923 – Variable Speed Drives
19. Section 23 3100 - Ductwork
20. Section 23 3300 - Ductwork Accessories
21. Section 23 3400 - Fans
22. Section 23 3600 – Air Terminal Units (VAV)
23. Section 23 3613 - Air Terminal Units (FPB)
24. Section 23 3700 - Air Inlets and Outlets
25. Section 23 4100 – Filters
26. Section 23 6426 – Air Cooled Liquid Chillers
27. Section 23 7300 - Fan Coil Units
28. Section 23 7323 – Air Handling Units
29. Section 23 8216 - Air Coils
30. Section 23 8233 – Electric Heating Coils

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit Fabrication Drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these Specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer. This entire building shall be considered as having tight spaces under condition (2) listed in this paragraph. Scaled shop drawings will be required for all ductwork, piping and equipment for each floor of this building.

F. If contractor submits equipment other than that specified or with any dimension lager than the basis of design (including fan powered boxes), he must also provide detailed shop drawings based on the equipment submitted to demonstrate adequate service clearance with a minimum of 3’-0” around mechanical equipment. Comply with NEC requirements for clearances around electrical gear.

G. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0". Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0". Submit three blueline prints of each Fabrication Drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one print with comments.

1.14 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment which will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the Specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these Specifications have been met and samples shall be furnished when requested. All manufacturers’ data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the Drawings and/or Specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s). No substitutions shall be allowed on DDC Controls Systems or Chemical Treatment Systems.

D. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered

acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

J. Physical Size of Equipment: **SPACE IS CRITICAL**; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the Shop Drawings. Such lists shall include but will not be limited to the following items:

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.15 MATERIALS AND WORKMANSHIP:

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request

advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.16 FLAME SPREAD PROPERTIES OF MATERIALS:

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.17 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the City of Houston. As such, it is required that the installation shall meet the minimum standards required by the Building Codes adopted by the City of Houston as well as those prescribed in the latest editions of the following listed codes and standards, which are made a part of these Specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA):

1. NFPA No. 13, Sprinkler System, Installation
2. NFPA No. 14, Standpipes and Hose Systems
3. NFPA No. 20, Centrifugal Fire Pumps
4. NFPA No. 37, Stationary Combustion Engines & Gas Turbines
5. NFPA No. 45, Fire Protection for Laboratories Using Chemicals
6. NFPA No. 51, Welding & Cutting, Oxygen-Fuel Gas Systems
7. NFPA No. 54, Gas Appliances, Piping, National Fuel Gas Code
8. NFPA No. 70, National Electrical Code
9. NFPA No. 72D, Proprietary Signaling Systems
10. NFPA No. 78, Lightning Protection Code
11. NFPA No. 88A, Standard for Parking Structures
12. NFPA No. 90A, Air Conditioning Systems
13. NFPA No. 91, Blower & Exhaust Systems
14. NFPA No. 101, Life Safety Code
15. NFPA No. 200, Series, Building Construction
16. NFPA No. 211, Chimneys, Fireplaces, Vent Systems
17. NFPA No. 241, Standard for Safeguarding Construction, Alteration and Demolition Operations
18. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials
19. NFPA No. 258, Standard Research Test Method for Determining Smoke Generation of Solid Materials

C. American National Standards Institute (ANSI):

1. A40.8, National Plumbing Code
2. B31.1, Power Piping
3. B9.1, Safety Code for Mechanical Refrigeration

D. American Gas Association Publications (AGA): Directory of Approved Gas Appliances and Tested Accessories

E. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

F. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.

G. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA): All current editions of applicable manuals and standards (See Sections 23 31 00 and 23 33 00).

H. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards.

I. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards.

J. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

K. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

L. City of Houston, Fire Department as may be applicable to construction on this site.

M. International Building Code, (Includes the International Mechanical and International Plumbing Codes)

N. Texas Occupational Safety Act: All applicable safety standards

O. Occupational Safety and Health Act (OSHA)

P. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

Q. Refer to Specification Sections hereinafter bound for additional Codes and Standards.

R. All materials and workmanship shall comply with all applicable state and national codes, Specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

S. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.18 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS:

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this Section of the Specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

H. All components of the ventilation system (e.g. Fans, ductwork, air handling units, terminal boxes, etc.) must be kept clean and dry as manufacturered, delivered, stored and installed before operation the HVAC system. If items are not kept clean, the contractor shall be required to wipe down all air handling equipment with isopropyl alcohol prior to installation.

1.19 WALL, FLOOR AND CEILING PLATES:

A. See Section 23 0529 – Sleeves, Flashings, Supports and Anchors.

1.20 SLEEVES, INSERTS, AND FASTENINGS:

A. See Section 23 0529 – Sleeves, Flashings, Supports and Anchors.

1.21 SOUND REQUIREMENTS

A. Mechanical systems have been designed to minimize sound levels in occupied spaces to comply with USGBC LEED acoustical requirements. The maximum acceptable sound levels shall be as shown below:

Type of Space	Maximum Allowable Sound Level Room Criteria Method RC (N)
Auditorium	25
Lerning Commons	25
Student Dining Commons	40
Gymnasium	40
Kitchen	40
High School Learning Center	30
All Other Occupied Spaces	35

1.22 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of the Architect/Engineer before proceeding.

1.23 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer’s directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.24 SPACE AND EQUIPMENT ARRANGEMENT:

A. The size of mechanical and electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.25 LARGE APPARATUS:

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.26 PROTECTION:

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage.

Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workmen or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

1.27 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS:

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.28 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT:

A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The Electrical Trades shall provide all interconnecting wiring for the installation of all power. The Electrical Trades shall provide all disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 26.

C. The Mechanical Trades shall provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control Drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the Electrical Trades by the Contractor. They shall be followed in detail. See Section 23 0923, DDC Systems, for additional clarification.

1.29 SUPERVISION:

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all Drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the A/E for ruling.

1.30 SITE OBSERVATION:

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall neither be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.31 PRECEDENCE OF MATERIALS

A. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.

B. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the contractor in the determination of which trade shall be given the "Right-of-Way."

1. Building lines
2. Structural Members
3. Soil and Drain Piping
4. Condensate Drains
5. Vent Piping
6. Supply, Return, and Outside Air Ductwork
7. Exhaust Ductwork
8. HVAC Water Piping
9. Fire Protection Piping
10. Natural Gas Piping
11. Domestic Water (Cold and Hot)
12. Electrical Conduit

1.32 CONNECTIONS FOR OTHERS:

A. The Mechanical Contractor shall rough in for and make all gas, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.

D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome plated lines provided by others shall be chrome plated to match.

E. Provide all sheet metal ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc., provided by others.

1.33 INSTALLATION METHODS:

A. Where to Conceal: All pipes, conduits, etc., shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping, ducts and conduits shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where

it crosses, rather than hung below them in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping, ducts and conduits run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping".

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 10 working days.

3. All above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, shall be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items. Adequate lighting shall be provided to permit thorough inspection of all above-ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager's Construction Inspector(s), the Resident Construction Manager, and U of H Facilities. Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.34 RECORDS FOR OWNER:

A. The Contractor shall maintain a set of prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these Drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide a set of reproducible drawings of the revised drawings. The contractor shall transfer the information from the prints maintained as described above, and turn over this neatly marked set of reproducible Drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. References to RFIs without the RFI attached to the sheet will not be acceptable. Contractor shop drawings attached to the Engineer's drawings will not be acceptable unless the Engineer's drawings have notes of specific areas where the contractor's shop drawings differ from the Engineer's drawings. These Drawings shall include as a minimum:

1. Addendum written drawing changes.
2. Addendum supplementary drawings.
3. Accurate, dimensioned locations of all underground utilities, services and systems.
4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
5. Change Order written drawing changes.
6. Change Order supplementary drawings.

C. Electronic Media:

1. In lieu of the drawings described above in 1.32B, it is preferred the contractor submit one set of prints and one set of discs containing all the drawings in AUTOCAD 2010 or later format.

D. "As installed" drawings shall bear a stamp, "stick on decal", or lettered title block generally located in lower right hand corner of Drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
2. Two sets and one electronic set on CD of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
3. Valve tag charts and diagrams specified herein.
4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
5. Copies of approved Shop Drawings.
6. Any and all other data and/or drawings required as submittals during construction.
7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.35 CUTTING AND PATCHING:

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

1.36 ROOF PENETRATIONS AND FLASHING:

A. Pipe, conduit and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.37 EXCAVATION, TRENCHING AND BACKFILL:

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths

required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

B. Backfilling:

C. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

D. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

E. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

F. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.38 ACCESS DOORS:

A. General: This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of mechanical equipment or devices.

B. Doors: Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacture, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surface of the adjacent finishes. Access doors mounted on tile surfaces shall be of similar construction as noted above, except they shall be of stainless steel materials. Access doors shall be a minimum of 12" x 12" in size.

1.39 OPERATION PRIOR TO COMPLETION:

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Construction Inspector's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.40 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT:

A. Before the work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. The qualifications of the representative shall be appropriate to the technical requirements of the installation. The qualifications of the representative shall be submitted to the owner for approval. The decision of the owner concerning the appropriateness of the representative shall be final. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each representative certifying as follows: "I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations".

B. Check inspections shall include plumbing equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.41 TESTS:

A. The Contractor shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association,

ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests which follow beneficial occupancy by the Owner will be borne by the Owner.

B. Additional tests specified hereinafter under the various Specification Sections shall be made.

C. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other Specification requirements requiring action on the part of the Construction Inspector. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

D. Maintain Log of Tests as hereinafter specified.

E. See Specifications hereinafter for additional tests and requirements.

1.42 LOG OF TESTS:

A. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance". All Test Log entries shall be legibly signed by the Project Contractor or his authorized job superintendent.

1.43 COMMISSIONING:

A. This project is to be commissioned. The Mechanical Contractor is required to work with the Commissioning Agent as noted in the Commissioning Specifications.

1.44 COOPERATION AND CLEANUP:

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.45 CLEANING AND PAINTING:

A. All equipment, piping, conduit, ductwork, grilles, insulation, etc., furnished and installed in exposed areas under Divisions 23 and 26 of these Specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 23 and Division 26 work.

B. All purchased equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

PART 2 PRODUCTS

2.2 Not Used.

PART 3 EXECUTION

3.1 PIPE PRESSURE TESTS:

A. The following lines shall be tested at the stated pressure for the length of time noted:

1. Testing Testing Pressure Time in

	Service	Medium	(PSIG)	Hours
3.	Chilled Water	Water	150	24
4.	Heating Water	Water	150	24
5.	Domestic Hot & Cold Water	Water	150	24
6.	Sanitary & Storm Piping	Water	Fill to top	24
7.	Natural Gas	Air	100	24
8.	Compressed Air	Air	150	24
9.	Compressed Gases	Nitrogen	150	24
10.	Lab Vacuum	Nitrogen	150	24

B. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

End of Section 23 0000

SECTION 23 05 13
MOTORS

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Single phase electric motors

B. Three phase electric motors

C. The Contractor shall provide all motors required for equipment supplied under this Division of the work

1.3 RELATED WORK

A. Section 22 1519 - Reciprocating Air Compressors

B. Section 23 2000 - HVAC Pumps

C. Section 23 2923 – Variable Speed Drives

D. Section 23 3400 - Fans

E. Section 23 3613 – Air Terminal Units (FPB)

F. Section 23 6000 – Gas Fired Boilers

G. Section 23 7300 – Fan Coil Units Fan motors

H. Section 23 7323 – Air Handling Units Fan motors

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. ANSI/IEEE 112 Test Method B - Test Procedure for Polyphase Induction Motors and Generators

D. ANSI/NEMA MG 1 - Motors and Generators

E. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

A. Submit product data under provisions of Section 23 0000

B. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.

C. Submit manufacturer's installation instructions under provisions of Section 23 0000

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 0000

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three—years documented product development, testing, and

manufacturing experience.

B. Acceptable Manufacturers:

1. Siemens
2. Reliance
3. Marathon
4. MagneTec
5. General Electric
6. Baldor

1.8 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 0000.

B. Store and protect products under provisions of Section 23 0000.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY

A. Provide three year manufacturer's warranty under provisions of Section 23 0000.

B. Motors failing during warranty shall be replaced with a new motor.

C. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Drawing Schedules for required electrical characteristics.

B. All Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

C. Totally Enclosed Motors: Design for a service factor of 1.15 and an 80 degrees C maximum temperature rise in the same conditions.

D. Visible Stainless Steel Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, bearing sizes, wiring diagram, manufacturer's name and model number, Service Factor, Power Factor, Nominal Efficiency, efficiency.

E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

F. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.

G. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

H. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

I. Dynamic Balance shall be no greater than the vibration limits of the driven equipment as defined in Section 23 3400 for fans and Section 23 2000 for pumps.

J. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

K. Motors under ½ HP shall be 120/1/60 unless provided with fan powered boxes at 277V. Motors 3/4HP and over shall be 480/3/60 with integral phase failure relay protection.

L. Motors shall not be selected to operate in the service factor.

M. Motors operating with variable frequency drives shall be specially designed for this application.

N. Motors located outside shall have cast iron enclosure.

O. Three phase motors located outside , where they may be subject to physical damage and in AHUs downstream of cooling coils shall be TEFC type.

2.2 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with drip-proof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class F insulation.

B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 480V 3-phase and shall be squirrel cage premium efficiency induction type with standard NEMA frame sizes.

C. Motors 1 HP and larger shall have integral frames and be provided with copper grounding lug.

D. Starting Torque: Between one and one and one-half times full load torque.

E. Starting Current: Six times full load current.

F. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B Characteristics.

G. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.

H. Insulation System: NEMA Class F or better.

I. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.1J.

J. Motor Frames: NEMA standard T-frames of cast iron with end brackets of cast iron.

K. Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory pre-packed with a non-detergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for B-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: Refer to ANSI/NEMA MG 1.

M. Weatherproof Epoxy Treated Motors (Where Indicated): Epoxy coat windings with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

N. Nominal Efficiency: Meet or exceed values for NEMA premium efficiency electric motors at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

O. Nominal Power Factor: Meet or exceed values per EPACT 2001 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

P. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

Q. Motors 10hp and larger shall be inverter duty rated and shall be provided with shaft grounding device.

2.6 STARTING EQUIPMENT:

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted. The Mechanical Subcontractor shall furnish all starters for Division 23 work, except those starters scheduled to be provided in Division 26 Motor Control Centers.

B. Control transformers shall have two primary fuses and one secondary fuse.

C. Motor starters shall conform to NEMA Standards for Industrial Control, #IC-1, latest issue, and shall be housed in NEMA Standard enclosures. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each starter as required. Manual starters for fractional horsepower single-phase motors shall be on-off or snap switch type combined with thermal overload device. The switch shall be so constructed so that it cannot be held closed under a sustained motor overload.

D. Magnetic starters shall have thermal overload protection in each of the ungrounded legs and shall be solenoid operated. Provide the correct size heater element to protect the motor and allow it to operate based on motor nameplate amperes and ambient temperatures anticipated for each individual motor. Each starter shall be provided with a control power transformer or 120v control power circuit.

E. Pushbuttons with or without pilot lights, hand-off-automatic switches, red-run/green-off lights and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled, and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

F. Hand-Off-Automatic switches for equipment which could damage itself if left in the "hand" position (such as sump pumps), shall be spring return to "off" from the "hand" position.

PART 3 EXECUTION

3.1 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors shall be premium energy efficient type.

D. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

E. Motors located in exterior locations for direct drive axial fans shall be totally enclosed type.

3.2 INSTALLATION

A. Provide foundations, supports and isolators properly adjusted to allow minimum vibration transmission within the building. Refer to Vibration Isolation Section 23 05 48.

B. Correct objectionable noise of vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

3.3 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600_RPM	1800_RPM	1200_RPM	900_RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.4 MOTOR EFFICIENCIES – NOMINAL, FULL LOAD, THREE PHASE

	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5
100	95.0	95.4	94.5	95.4	95.4	94.5
125	95.4	95.4	95.0	95.4	95.4	95.0
150	95.8	95.8	95.4	95.8	95.8	95.4
200	95.4	95.8	95.4	95.8	96.2	95.8

END OF SECTION 23 05 13

SECTION 23 0529

SLEEVES, FLASHINGS, SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.3 RELATED SECTIONS

A. Section - Cast-In-Place Concrete: Equipment bases

B. Section - Firestopping: Joint seals for piping and duct penetration of fire rated assemblies

C. Section - Painting

D. Section 23 0548 - Vibration Isolation

E. Section 23 0719 - Piping Insulation

F. Section 23 0716 - Equipment Insulation

G. Section 23 0713 - Ductwork Insulation

H. Section 22 1316 - Plumbing Piping

I. Section 23 2113 - Hydronic Piping

1.4 REFERENCES

A. ASME B31.1 - Power Piping

B. ASME B31.9 - Building Services Piping

C. ASTM F708 - Design and Installation of Rigid Pipe Hangers

D. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer

E. MSS SP69 - Pipe Hangers and Supports - Selection and Application

F. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of plumbing, hydronic, steam and steam condensate piping.

PART 2 PRODUCTS

2.1 HANGERS AND SUPPORTS

A. Manufacturers:

1. Grinnell.
2. Kindorf
3. B-Line
4. Power Strut

B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.

D. The supports, hangers, anchors, and guides for the chilled water supply and return piping, heating water supply and return piping, steam piping, condensate return piping, etc. of the System routed through the building shall be provided as indicated on the Drawings, details and within this specification.

E. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

F. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

G. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

H. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

I. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.

J. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

K. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be clevis type. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Grinnell Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.

L. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8" diameter pipe or smaller in size and supporting all ferrous lines 6" and smaller in size shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

M. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Grinnell Fig. 260,

adjustable clevis, with a nut above and below the hanger on the support rod.

N. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

O. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support shields as specified in Section 23 0719 - PIPING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.

P. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Grinnell Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two-hole rigid pipe clamps at 4 ft. o.c. or Kindorf channels and Grinnell Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators (see Section 23 05 48 - Vibration Isolation). Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with copper strut clamps as manufactured by Specialty Products Company, Stanton, California.

Q. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use a Grinnell No. 595 Socket Clamp with Grinnell No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

R. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

S. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips." All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers. Where feasible, conduits may be fastened to the concrete by one-hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above-ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

1. Vertical conduits shall be supported as often as necessary for rigidity by clamps resting on

adjacent beams or floor slabs, using a minimum of one support per floor.

T. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

U. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping or ductwork that may vibrate and create an audible noise shall also be isolated. Spring hangers or supports shall be provided where indicated on the Drawings and/or specified under Section 23 0548.

V. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:

a. Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.

e. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

f. If it is necessary to install a method of fastening a hanger after the structure has been installed,

then only clamps or drilled anchors shall be used.

g. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

h. Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

W. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Uni-Strut, Power Strut, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

X. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. Universal concrete inserts shall be cadmium plated.

Y. Ductwork: All ductwork shall be supported in accordance with the SMACNA recommendation for the service involved; however, all horizontal ductwork shall be supported at intervals not to exceed the scheduled values indicated elsewhere in this section. Horizontal ducts shall be supported using galvanized steel bands extending up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete bolted to angles secured to the construction above, or secured in another approved manner. For attaching methods for precast double tee structural concrete, refer to details on the Drawings and as specified herein.

Z. Terminal units shall be supported by four 16 gauge, 1" wide sheet metal straps with ends turned under bottom of box at corners. Each band shall be secured by not over 3/4" in length, 1/4" diameter sheet metal screws - two on bottom of box and one on side. The other strap end shall be attached to the structure by 1/4" diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor. Where interferences occur, overhead of the box, not allowing direct vertical support by straps, provide trapezes of Kindorf, Unistrut, or B-Line channel suspended by 1/4" diameter galvanized threaded rods providing such channels do not block access panels of boxes. Threaded rods shall be supported from structure by concrete insert or by drilled-hole threaded concrete expansion anchor.

AA. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

2.2 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.3 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized or stainless steel steel.

B. Metal Counterflashing: 22 gauge galvanized or stainless steel steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

E. Curbs: Welded 18 gauge galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, factory installed wood nailer.

2.4 CONCRETE FOUNDATIONS ("Housekeeping Pads"):

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

2.5 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.6 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, conduit, cable trays, etc., shall be sleeved. Ductwork shall be sleeved as noted in the schedule following. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary except in wet areas (such as restrooms, mechanical rooms, cagewash areas, etc.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.
2. Sleeves through interior walls to be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.
3. Ductwork

System	Non-Rated Gyp Wall	1 Hr. Rated Gyp Wall	2 Hr. Rated Gyp Wall	Interior Masonry Wall	Exterior Wall
Ductwork (no ext. insulation)	3	3	6	1,5,6	1,4
Duct (ext insulated)	3, 7	1, 2,7	6	1,5,6	1,4

Keyed Notes
1. Split or tack welded 20 ga. S.M. sleeve or EMT (1” min. size)

2. Fire sealed in accordance with submitted UL assembly.
3. Taped and floated.
4. Caulked and/or flashed watertight.
5. Caulked or fire sealed as required by partition rating.
6. Per UL fire or F/S damper installation instructions if damper required by wall rating.
7. If medium pressure duct wall to be sleeved or framed and sound or fire caulked as required by the wall rating. No contact shall exist between the ductwork and the wall system.

Notes:
-All sleeving/openings on fire sealed penetrations to have proper annular/depth

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

G. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

H. Fireproofing: Seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000° F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be a silicone RTV foam or an approved equal. For dry locations, a premixed putty equal to Nelson Flameseal Firestop putty may be used. Refer to the Fireproofing specifications for further information. All fireproofing for all trades shall be done by one contractor, hired under the General Contractor.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.

L. Hanger Rods: NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.

M. Multiple trades may be allowed to hang off of the same hangers or trapeze as long as the hangers were sized for the total load of all equipment to be supported and there is not a physical way to do otherwise. Each instance shall be required to have the acceptance of the U of H Construction Manager and the Engineer.

3.4 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor, mop sink, and flop sink drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

F. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.5 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors (except in stairwells) two inches above finished floor level. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where piping, ductwork or conduit penetrates floor, ceiling, or wall, close space between pipe or duct and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.6 PIPE SUPPORT SCHEDULES

Inches	MAX. HANGER SPACING Feet	HANGER ROD DIAMETER Inches
STEEL PIPE		
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1
PP, PVDF, PVC, CPVC		
(All Sizes)	4	3/8
C.I. Bell and		
Spigot (or No-Hub),	5	5/8
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 4	10	1/2
5 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1
	and at all Joints	
Glass,	4	1/2
	and at all Joints	

3.7 LOW PRESSURE DUCT SUPPORT SCHEDULE:

A. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.

B. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8' 0" on centers according to the following:

Angle Length	Angle	Rod Diameter
4’ 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8' 0"	2" x 2" x 1/8"	5/16"
10' 0"	3" x 3" x 1/8"	3/8"

C. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60.” Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

3.8 MEDIUM PRESSURE DUCT SUPPORT SCHEDULE:

A. All horizontal rectangular ducts shall have duct hanger requirements as follows:

3.9 Minimum Hanger Size

Max. Duct Dimen.	Steel Rod	Galv. Steel Strap Width	Max. Spacing	Min.# Hngrs	Trapeze Size
0 through 18"	--	1" x 16 ga.	10'	2	--
19" through 36"	--	1" x 16 ga.	10'	2	--
37" through 60"	3/8"	1" x 16 ga.	8'	2	2" x 2" x 1/4"
61" through 120"	3/8"	1-1/2" x 12 ga.	8'	2	2" x 2" x 1/4"
121" through 240"	3/8"	--	4'	3	2 1/2"x2 1/2"x 3/16"

A. All horizontal round ducts shall have ducts hangers spaced 10' 0" maximum with requirements as follows:

Duct Diameter	Min. Hanger Size	No. Hangers	Hanger Ring Size
Up through 18"	1" x 16 gauge	1	1" x 16 ga.
19" to 36"	1" x 12 gauge	1	1" X 12 ga.
37" to 50"	1-1/2" x 12 gauge	1	1-1/2" x 12 ga.
51" to 84"	1-1/2" x 12 gauge	2	Support Bracing Angle

3.10 DUCT HANGERS - GENERAL NOTES (all pressures)

A. Hanger straps on duct width of 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the side.

B. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8" bolts minimum.

C. Use 3/8" minimum bolts for securing duct hanger to band straps.

D. All round ducts shall be supported within 3 feet of all horizontal or vertical turns.

End of Section 23 0529

SECTION 23 0548
VIBRATION ISOLATION

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. 23 0000 -- Basic Mechanical Requirements

B. 23 0529 -- Sleeves, Flashings, Supports and Anchors

C. 23 0553 -- Mechanical Identification

1.2 WORK INCLUDED

A. Inertia bases

B. Vibration isolation

1.3 SCOPE OF WORK:

A. Furnish and install all labor, materials, equipment tools and service and perform all operations required in connection with or properly incidental to the construction of complete system of vibration and noise control, as indicated on the Drawings, reasonably implied therefrom or as specified herein, unless specifically excluded.

1.4 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves

1.5 QUALITY ASSURANCE

A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 0000.

B. Indicate inertia bases on shop drawings.

C. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.

D. Submit manufacturer's installation instructions under provisions of Section 23 0000.

1.7 CERTIFICATES

A. Submit a certificate from the manufacturer that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

1.8 INTENT OF RESPONSIBILITY:

A. It is the intent of this specification to provide for vibration isolation supports for all equipment, piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria, and one

which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Concrete housekeeping pads and inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.

C. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

D. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

E. Vibration isolation devices shall be as manufactured by Mason, Amber/Booth Company, Noise Control, or approved equal.

PART 2 PRODUCTS

2.1 GENERAL DESIGN FEATURES:

A. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.

B. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cad-plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

C. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.

D. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.

E. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or

less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

F. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".

G. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

H. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

2.2 ISOLATOR TYPES: Isolator types and required deflections are specified under "Schedule of Isolated Equipment," paragraph 3.02. The isolators shall comply with the following descriptions for each type required on the project:

A. Type 1 - An adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring(s) shall be rigidly attached to the mounting base plate and to the spring compression plate. The isolator shall be designed for a minimum Kx/Ky (horizontal to vertical spring rate) of 1.0. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate. Base plates shall be sized to limit pad loading to 100 psi.

B. Type 2 - An aluminum-housed, or cast iron housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Sheet or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate.

C. Type 3 - An adjustable, open-spring isolator having one or more coil springs attached to the top compression plate and a base plate. The isolator shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4" and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion. The spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts which shall not be engaged during normal operation shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of water.

D. Type 4 - A pad-type mounting consisting of two layers of 3/8" thick, ribbed or waffled, Neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi load, or a deflection of 0.10" to 0.16".

E. Type 5 - A spring hanger consisting of a rectangular steel box, coil springs, spring cups, Neoprene impregnated fabric washer, steel washer, and Neoprene insert designed to prevent metal to metal contact between the hanger rod and bottom of the hanger box. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.

F. Type 6 - A spring hanger, as described in Type 5, with the addition of an elastomeric element at the top of the box for acoustic isolation. The design shall be such to prevent metal - to metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type 3 mountings.

G. Type 7 - An elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additive. The elements shall be so designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

H. Type 8 - 1/4" thick closed cell Neoprene ASTM Grade S.E.C. 44 in sheets cut to fit penetrations, as required.

2.3 BASE TYPES: Base types and required deflections are specified under "Schedule of Isolated Equipment," paragraph 7.8, or are indicated on the Drawings. The bases shall comply with the following descriptions for each type required on the project.

A. Type B-1 - A structural steel fan and motor base with motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically shall be sized to limit deflection of the beam on the drive side to 0.05" due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.

B. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height-saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

C. Type B-3 - An extended aluminum rail base for rooftop air conditioning units consisting of a pair of weatherproofed aluminum rails for fastening to equipment and to the roof curb incorporating wind restraints and a continuous air and water seal which is protected from accidental puncture and direct sunlight by an aluminum weather shield. Rails shall incorporate nonadjustable Type SW spring isolators properly spaced around perimeter and sized for one inch (1") deflection. To prevent leaks, rails shall be factory-assembled (to the limits of freight carriers) and shipped as a one-piece unit.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for 1-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2-inch clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

D. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, to be mounted on the scheduled vibration isolator type to prevent the transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After the piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. The isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length which will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load.

E. Piping:

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights, and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional 1/2" deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

F. Resilient Sleeves:

1. Resilient sleeves shall be provided at all points where equipment room walls, floors, or ceilings are penetrated by ducts, piping, or refrigerant line, etc.

G. Fans and Air Handling Units:

1. Such units shall have electrical flexible connections not less than 36" long and the flexible duct connections with a free length of not less than 8". Air handling unit fan connections shall be moisture-tight.

3.2 SCHEDULE OF ISOLATED EQUIPMENT:

A. Tabulated below is a schedule of equipment on this project requiring vibration isolation and base isolators of the types listed above. Any equipment, system, construction or condition that may be altered, added, or changed; or that is not specifically considered herein or on the plans shall be treated in a manner that is set out for similar equipment system or construction in order to comply with the above requirements heretofore cited.

EQUIPMENT	ISOLATOR EQUIP. TYPE	ISOLATOR DEFLECTION	BASE ISOL. TYPE
Roof Mounted Fans	1	2"	B-1
Hanging Fans	6	2"	---
Transformers	8	---	B-1

Piping	5	1"	---
All piping and duct floor penetrations in equipment room	8	---	---
Piping in Mechanical Rooms	5	1"	---
All piping and duct floor penetrations	8	---	---
All pipe and duct wall penetrations	8	---	---
Pumps, vacuum pumps and air compressors	2	1”	B-2
Fan Coil Units	7	1”	---
Air Handling Units	4	Internally Isolated	
Roof Mounted Air Units	4	Internally Isolated	B-3
Hermetic Centrifugals	--	Internally Isolated	B-1

End of Section 23 0548

SECTION 23 05 53
MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

1.2 SECTION INCLUDES

A. Nameplates

B. Tags

C. Stencils

D. Pipe Markers

1.3 RELATED SECTIONS

A. Section - Painting: Identification painting

1.4 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems

1.5 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.

F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 0000.

B. Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

B. Chart: Typewritten letter size list in anodized aluminum frame.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

1.2 CEILING TACKS

A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

B. Color code as follows:

1. Yellow - HVAC equipment

2. Red - Fire dampers/smoke dampers

3. Green - Plumbing valves

4. Blue - Heating/cooling valves

2.2 General: The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings.

2.3 Mechanical: All items of mechanical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed Gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

Pumps
Fan and Coil Units
Electric Duct Heaters
Air Handling Units
Air Compressors
Terminal Units
Panels and Switches
Exhaust Fans
Compressors
Substations
Plumbing Pumps
Vacuum Systems
Air Cooled Chillers
and/or related items

2.4 Piping: Pipe markers and arrow markers also shall be provided on but not limited to the piping of the following systems:

Natural Gas	Kitchen Hot Water
RO Water	
Building Chilled Water Supply	Domestic Water
Building Chilled water Return	Compressed Air
Roof Drain	Domestic Hot Supply
Domestic Hot Return	Lab Waste
Fire Suppression Water	Lab Vent

2.5 Electrical: Nameplates shall be 2 or 3 ply laminated plastic, a minimum of 3/32" thick, such that letters will be white on black background. Letters shall be similar to Roman Gothic of a size that is legible and appropriate to the application. Attachment of nameplates shall be by screws. Rivets or adhesives are not acceptable.

A. Electrical equipment to be identified includes: All switchgear, distribution panels, transformers, motor control centers, panel boards, disconnect switches, starters, contactors and time switches.

B. Nameplates on distribution panels, motor control centers and panel boards shall give voltage characteristics.

C. Example:

1. PANEL LA

2. 120/208V, 3 PH, 4 W

3. served from _____.

D. Individual circuit breakers in distribution panels, individual units in motor control centers, disconnecting means, and motor starters, shall have nameplates showing the load served.

E. Branch circuit panel boards shall have neatly typed circuit directories behind clean plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner, not necessarily those given on contract Drawings. If a circuit serves more than one room, list each room. Spares and spaces shall be indicated with erasable pencil, not typed.

2.6 The Contractor shall prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:

HPS-1-3 High Pressure Steam	1st Level - Valve No. 3
CHS-2-4 Chilled Water Supply	2nd Level - Valve No. 4

2.7 Valve Tags:

A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10' and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8" thick brass discs, 1 1/2" in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

B. Valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2" wide by 1 1/2" high with these color codlings: Red = normally closed; Green = normally open; Blue = open in winter, closed in summer; and Yellow = closed in winter, open in summer. Tags should be engraved on both sides.

2.8 In addition, pipe runs throughout the building including those above lift out ceilings, under floor, and those exposed to view when access doors or access panels are opened shall be identified by means of Seton Setmark or Brady Mechanical Pipe Markers. Concealed areas, for purposes of this identification section, are those areas which cannot be seen except by demolition of the building elements. In addition to the pipe markers, arrow markers shall be used to indicate direction of flow. The following specific instructions shall apply to the application of these markers:

A. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one header, it is necessary to mark only the header.

B. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

C. Provide a double ended arrow marker when flow can be in either or both directions.

D. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.

E. Provide pipe markers and arrow markers at intervals not exceeding 25 feet.

F. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.

G. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, 3/4" thru 6". For piping systems larger than 6", use Seton or Brady strap on markers.

H. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems." Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

I. Locate markers to be visible from floor.

2.9 Specials: Refer to special requirements noted in the various sections hereinafter bound.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Painting Section for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Painting Section.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

F. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify thermostats relating to terminal boxes or valves with nameplates.

J. Identify valves in main and branch piping with tags.

K. Identify air terminal units and radiator valves with numbered tags.

L. Tag automatic controls, instruments, and relays. Key to control schematic.

M. Provide ceiling tacks to locate valves, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

End of Section 23 0553

SECTION 23 0593
SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. 23 0000 -- Basic Mechanical Requirements

B. 23 0529 -- Sleeves, Flashings, Supports and Anchors

C. 23 0553 -- Mechanical Identification

1.2 SUMMARY

A. Testing, adjusting and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed by the Owner, separate and apart from the construction contract. TAB contractor shall bid directly to HISD based on this specification.

B. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.

1.3 QUALIFICATIONS

A. Acceptable TAB Contractors shall be Engineered Air Balance and Precision Air.

B. The Firm shall be one which is organized to provide professional services of this specified type in the State of Texas and as a minimum shall have one (1) professional engineer licensed in the State of Texas, with current registration, to perform such professional services. This engineer shall be personally responsible for developing the job site data as required in the test procedures outlined in these Specifications. The Engineer shall have at least three years of successful testing and balancing experience on similar projects.

C. The TAB agency shall be certified by NEBB or AABC in the testing procedures required by this project. At least one Professional Engineer registered in the State of Texas must be certified by NEBB or AABC as at test and balance Engineer.

D. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.

E. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.

F. The TAB firm shall submit biographical data on the individual proposed who will directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.

1.4 REFERENCES

A. AABC - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. ASHRAE - 2007 HVAC Applications Chapter 37: Testing, Adjusting and Balancing.

C. ANSI/ASHRAE Standard 111-1988 - Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.5 DOCUMENTS

A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, and the following:

1. One complete set of Drawings less the structural sheets.

2. One set of mechanical floor plans.

B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.6 through 1.10 of this Specification will be available through the Construction Inspector.

1.6 SUBMITTALS

A. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.

B. Engineer and Technicians Data: Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed to be used for this project.

D. Sample Forms: Submit sample forms, if other than those standard forms, if other than those standard forms prepared by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) are proposed.

E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of hoe the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Draft Reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit two complete sets of draft reports. Only one complete set of draft reports will be returned.

2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit two complete sets of final reports.

3. Report Contents: Provide the following minimum information, forms and data:

a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, the Company, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.

c. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.7 QUALITY ASSURANCE

A. Test and Balance Engineer's Qualifications: A Professional Engineers registered in the State in which the services are to be performed, and having at least three years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.

B. Agency Qualifications:

1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to the test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

2. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB or AABC as a Test and Balance Engineer.

C. Codes and Standards

1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

2. AABC: "National Standards for Total System Balance."

3. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) ASHRAE Handbook, 1999 HVAC Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.

D. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of the system operation and readiness for testing, adjusting, and balancing.

E. Systems shall be fully operational prior to beginning procedures.

F. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.

G. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within five degrees Fahrenheit wet bulb temperature of maximum summer design condition, and within ten degrees Fahrenheit dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.

H. Provide minimum 7 days advanced notice. Include scheduled test dates and times.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 RESPONSIBILITIES OF THE TAB FIRM

A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC 2002 Standard, Sixth Edition.

B. Liaison and Early Inspection:

1. The TAB firm personnel on the job shall act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:

a. During the design stage, before the documents are finalized, review the mechanical drawings and specifications for balanceability and provide commentary.

b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balanceability.

c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the HISD Construction Project Manager of each observation.

C. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

D. Furnish instruments required for testing, adjusting, and balancing operations.

E. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

F. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.2 INSTALLATION TOLERANCES

1. Set HVAC system's air flow rates and water flow rates within the following tolerances:

2. Supply, Return, and Exhaust fans and Equipment with Fans: +/- 5%

3. Air Outlets and Inlets: +/- 5%

4. Heating-Water Flow Rate: +/- 5%

5. Cooling-Water Flow Rate: +/- 5%

3.3 ADJUSTING

A. Verify recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries in clean rooms.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from construction manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for airhandling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-

heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitottube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum setpoint airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this

adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.

2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant volume air systems.

4. Readjust fan airflow for final maximum readings.

5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.

6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

A. Balance systems with automatic two and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Measure water flow at pumps. Use the following procedures except for positive displacement pumps:

   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

      a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner/Engineer and comply with requirements in "Hydronic Pump Specification."

   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

      a. Monitor motor performance during procedures and do not operate motors in overload conditions.

   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

   4. Report flow rates that are not within plus or minus 10 percent of design.

C. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

D. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

E. Set calibrated balancing valves, if installed, at calculated pre-settings.

F. Measure flow at all stations and adjust, where necessary, to obtain first balance.

   1. System components that have Cv rating or an accurately cataloged flow pressure-drop relationship may be used as a flow-indicating device.

G. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

H. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

   1. Determine the balancing station with the highest percentage over indicated flow.

   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

   3. Record settings and mark balancing devices.

I. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

J. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

K. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

1.2 SOUND VIBRATION AND ALIGNMENT

A. Sound: Read and record sound levels at up to 15 locations in the building designated by the Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet in the presence of the Engineer, if he so desires.

B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil on fans and 1 mil on pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.3 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. In the process of performing the TAB work, the TAB Agency shall:

1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.

2. Verify that all control devices are properly connected.

3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.

4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).

5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in terminal boxes and fire/smoke dampers.

6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.

7. Observe the calibration of all controllers.

8. Verify the proper application of all normally opened and normally closed valves.

9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.

10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.

11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.

12. Verify that all controller setpoints meet the design intent.

13. Check all dampers for free travel.

14. Verify the operation of all interlock systems.

15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

3.2 REPORTS

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title Page

2. Name and address of the TAB contractor.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Instrument List
1. Instrument
2. Manufacturer
3. Model
4. Serial Number

5. Range
6. Calibration date
7. What test instrument was used for

B. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches
3. Test Data (Indicated and Actual Values):
    a. Total air flow rate in cfm (L/s).
    b. Total system static pressure in inches wg (Pa).
    c. Fan rpm.
    d. Discharge static pressure in inches wg (Pa).
    e. Filter static-pressure differential in inches wg (Pa).
    f. Preheat-coil static-pressure differential in inches wg (Pa).
    g. Cooling-coil static-pressure differential in inches wg (Pa).
    h. Heating-coil static-pressure differential in inches wg (Pa).
    i. Outdoor airflow in cfm (L/s).
    j. Return airflow in cfm (L/s).
    k. Outdoor-air damper position.
    l. Return-air damper position.

m. Vortex damper position.

C. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.

b. Location.

c. Coil type.

d. Number of rows.

e. Fin spacing in fins per inch o.c.

f. Make and model number.

g. Face area in sq. ft

h. Tube size in NPS (DN).

i. Tube and fin materials.

j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).

b. Average face velocity in fpm (m/s).

c. Air pressure drop in inches wg (Pa).

d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).

e. Return-air, wet- and dry-bulb temperatures in deg F (deg C)

f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).

g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).

h. Water flow rate in gpm (L/s).

i. Water pressure differential in feet of head or psig (kPa).

j. Entering-water temperature in deg F (deg C).

k. Leaving-water temperature in deg F (deg C).

l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig (kPa).

n. Refrigerant suction temperature in deg F (deg C).

o. Inlet steam pressure in psig (kPa)

D. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches .

g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg (Pa).

c. Fan rpm.

d. Discharge static pressure in inches wg (Pa).

e. Suction static pressure in inches wg (Pa).

E. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in deg F.

d. Duct static pressure in inches wg (Pa).

e. Duct size in inches.

f. Duct area in sq. ft..

g. Indicated air flow rate in cfm.

h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig (Pa).

F. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.

b. Location and zone.

c. Apparatus used for test.

d. Area served.

e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

G. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm (L/s).
b. Entering-water temperature in deg F
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

H. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curve and include the following:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig (kPa).

h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig (kPa).
b. Pump shutoff pressure in feet of head or psig (kPa).
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig (kPa).
f. Final discharge pressure in feet of head or psig (kPa).
g. Final suction pressure in feet of head or psig (kPa).
h. Final total pressure in feet of head or psig (kPa).
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

I. Vibration Test:
1. Location of points:
a. Fan bearing, drive end
b. Fan bearing, opposite end
c. Motor bearing, center (when applicable)
d. Motor bearing, drive end
e. Motor bearing, opposite end
f. Casing (bottom or top)
g. Casing (side)
h. Duct after flexible connection (discharge)
i. Duct after flexible connection (suction)

2. Test readings:
a. Horizontal, velocity and displacement
b. Axial, velocity and displacement
c. Normally acceptable readings, velocity and acceleration

d. Unusual conditions at time of test
e. Vibration source (when non-complying)

J. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

L. Location of points:
1. Fan bearing, drive end
2. Fan bearing, opposite end
3. Motor bearing, center (if applicable)
4. Motor bearing, drive end
5. Motor bearing, opposite end
6. Casing (bottom or top)
7. Casing (side)
8. Duct after flexible connection (discharge)
9. Duct after flexible connection (suction)
10. Test readings:
a. Horizontal, velocity and displacement
b. Vertical, velocity and displacement
c. Axial, velocity and displacement
11. Normally acceptable readings, velocity and acceleration
12. Unusual conditions at time of test
13. Vibration source (if non-complying)
14. Control verification indicating date performed and any abnormalities identified.
15. Point Location/Description
16. EMS Readout (Setpoint and Actual)
17. Actual Readout
18. Interlocks
19. Safeties
20. VSD Normal Operation
21. VSD Bypass Operation

22. Alarms

23. Sequences of Operation

End of Section 23 0593

SECTION 23 05 94
SYSTEM PREPARATION FOR TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SUMMARY

A. Perform all work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:

1. Responsibilities of project contractor

2. Preparation for balancing of air systems

3. Preparation for balancing of hydronic and steam systems

B. The scope of the TAB work as defined in Section 23 0593 is indicated in order that the Contractor will be advised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB. The TAB firm will not have a contractual relationship with any Contractor referred to herein, but will be responsible to the Construction Inspector and the Owner for the satisfactory execution of the TAB work. The Contractor in his original bid shall allow for the costs required to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.3 RELATED SECTIONS

A. Section - Starting of Systems

B. Section 23 0548 - Vibration Isolation

C. Section 23 2123 - Hydronic Specialties

D. Section 23 2000 - HVAC Pumps

E. Section 23 8216 - Air Coils

F. Section 23 7300 - Fan Coil Units

G. Section 23 7323 - Air Handling Units

H. Section 23 3400 - Fans

I. Section 23 3100 - Ductwork

J. Section 23 3300 - Ductwork Accessories

K. Section 23 3613 - Air Terminal Units (FPB)

L. Section 23 3700 - Air Outlets and Inlets

M. Section 23 0923 - Direct Digital Control Systems

N. Section 23 0963 – Space Pressurization Tracking System

O. Section 23 0993 - Sequence of Operation

P. Section 23 0593 - System Testing, Adjusting & Balancing

1.4 SCOPE OF WORK

A. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.
16. Re-sheave

B. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed directly by the Owner, separate and apart from the Construction Contract. However, the preparation for and corrections necessary for the Testing, Adjusting and Balancing of these systems, as described herein, are the responsibility of the Contractor and shall be included in the Contractor’s base bid price.

C. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc. required for correct balance as advised by the TAB firm, at no additional cost to the Owner.

D. For motors with a variable frequency drive, contractor shall provide belt and sheave adjustment such that units deliver their design cfm when speed drive is at 60 hertz.

E. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.

F. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate said systems at his expense for the length of

time necessary to properly verify their completion and readiness for TAB. This length of time shall be subject to the approval of the Construction Inspector.

G. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The contractor shall allow adequate time for the testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

H. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Construction Inspector shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.5 RESPONSIBILITIES OF THE PROJECT CONTRACTOR:

A. The Contractor shall:

1. Have the building and air conditioning systems in complete operational readiness for TAB work to begin.

2. The contractor shall allow sufficient time for the TAB firm to perform his contracted work within the construction schedule. The contractor shall complete his work by systems or floors whichever is the most efficient for scheduling. After awarding of the contract and the contractor has developed a construction schedule, a TAB coordination meeting shall be held at the RCM's office with the TAB agency, the general contractor and his primary subcontractors (i.e. mechanical, electrical, building automation etc.) to develop a testing schedule for the project. The contractor shall submit copies of the proposed schedule two (2) weeks prior to this meeting to the RCM and TAB Agency.

B. TAB Agency will provide Engineer with tentative schedules for each area, floor and/or system to be included in this section.

C. Note: The hot water and chilled water systems must be 100% complete to balance. The air systems are pressure independent and can be balanced by floors, risers, systems, etc., but once the total system is complete the total flows and system tracking will require finalization. Lab certification will be performed when the building is 100% operational and balanced.

1. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.

2. Be responsible for any added costs to the Owner resulting from his failure to have the building and air conditioning systems ready for TAB when scheduled, or from his failure to correct deficiencies promptly.

D. Complete operational readiness of the building requires that construction status of the building shall permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.

E. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:

1. Air Distribution Systems:

a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by the Specification.

b. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.

c. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices installed.

d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessive bypass or leakage of air.

e. All fans (supply, return and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating; record motor amperage and voltage on each phase at start-up and running, and verify they do not exceed nameplate ratings.

f. All single duct variable and constant volume terminal units ("mixing boxes") shall be installed and functional (i.e. controls functioning).

2. Water Circulating Systems:

a. Check and verify pump alignment and rotation.

b. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and checked for proper operation, remove and clean all strainers. The Contractor shall repeat the operation until circulating water is clean.

c. Record each pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.

d. Verify that the electrical heater elements are of the proper size and rating.

e. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.

f. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

3. Automatic Controls:

a. The Contractor shall schedule a meeting with the Engineer, Control Contractor, TAB firm and Owner's representative for a pre-submittal review to establish that their interpretations of the sequences of operation are correct.

b. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, dampers sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.

c. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB firm and Control Contractor.

d. The Automatic Temperature Control Contractor and/or Energy Management System Contractor shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB agency that the Automatic Temperature Controls and Energy Management System are operational. The Automatic Temperature Contractor and/or

Energy Management System Contractor shall provide technical support (technicians and necessary computers) to the TAB agency for a complete check of these systems.

4. Tabulated Data: The motor amperages, voltages shall be recorded showing "actual" and "nameplate" voltage and amperage and submitted and actual RPM. This applies to each piece of electrically driven air conditioning equipment in the system including supply and exhaust fans, fans of fractional horsepower, pumps, etc.

F. Notification of System Readiness:

1. After completion of the work in Paragraph 1.5 A through E above, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing. He shall include a copy of the tabulated data of Paragraph 1.5E.4 above.

2. The Owner will, in turn, notify the TAB firm of the readiness for balancing and forward copies of the Contractor's certification and the tabulated voltages and currents.

3. Should the TAB firm be notified as described above, and the TAB work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by duly appointed representative of the Owner, Architect, TAB firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriated parties by the Project Contractor.

1.6 RESPONSIBILITIES OF THE TAB FIRM

A. Refer to Section 23 0593 entitled "System Testing, Adjusting and Balancing".

End of Section 23 0594

SECTION 23 07 13
DUCTWORK INSULATION

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Ductwork insulation

B. Insulation jackets

1.3 RELATED SECTIONS

A. Section - Painting: Painting insulation jackets

B. Section 23 3100 - Ductwork: Duct liner & Flex Duct

C. Section 23 3300 - Ductwork Accessories: Duct liner

1.4 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation

D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation

E. ASTM E84 - Surface Burning Characteristics of Building Materials

F. ASTM E96 - Water Vapor Transmission of Materials

G. NFPA 255 - Surface Burning Characteristics of Building Materials

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

I. UL 723 - Surface Burning Characteristics of Building Materials

J. IECC 2004.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Samples: Submit two samples of any representative size illustrating each insulation type.

D. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

B. Acceptable Manufacturers:

1. Glass Fiber: Knauf, Johns Manville, Owens Corning

2. Adhesives: Minnesota Mining, Arabol, Armstrong

3. Ceramic Fiber: Primer Refractories, A.P. Green Refractories

4. Approved Equal: Obtain written approval from HISD for any suggestions.

1.7 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 0000.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 Insulation A:

A. Three pound per cubic foot minimum density glass fiber semi-rigid board insulation with fiber perpendicular to the surface and with factory applied white foil reinforced vapor barrier jacket (ASJ).

B. The insulation shall be secured to the ducts with mechanical fasteners; "Stick-clips", Graham Pins or Speed Clips, and shall be spaced approximately 12" on center on bottom of duct and where required elsewhere to hold insulation securely against the duct as noted in the published recommendations of the Insulation Manufacturer.

C. After insulation is in place, all joints and seams shall be sealed with Foster 30-35 white vapor barrier emulsion applied over a 3" wide strip of Duramesh Glass Fabric. All protrusions through the vapor barrier shall be thoroughly sealed.

D. On ducts that are reinforced with standing seams or angle iron stiffeners 1" and over in height, the Contractor shall apply a strip of fiberglass board 1" thick by 6" wide, sealing same to the other insulation with mastic.

E. Vapor sealing of joints and seams is not required on hot duct application where concealed.

2.2 Insulation B:

A. Three pound per cubic foot minimum density glass fiber rigid board insulation with factory applied white foil reinforced All Service Jacket (ASJ).

B. Insulation B shall be applied as specified for Insulation A.

C. Contractor at his option may substitute Insulation A where Insulation B is called for.

2.3 Insulation C:

A. Blanket insulation with a thermal conductivity (K) of 0.27 or less similar in construction to Owens-Corning Fiberglass Series one pound per cubic foot minimum density with foil reinforced Kraft (FRK) vapor barrier facing. Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2". Adhere insulation to metal with 4" strips of insulation bonding adhesive at 8" on center. On circumferential and longitudinal joints, the 2" flange of the facing shall be secured using 9/16" flare door staples applied 6" on center and taped with 4" wide fiberglass tape embedded in Foster 30-35 white vapor barrier Emulsion and covered with Foster 30-35 white vapor barrier Emulsion until the tape is completely covered. All pin penetrations or punctures in facing shall also be taped. Vapor sealing of joints is not required on hot duct application where concealed.

2.4 Vapor Seal Emulsion – Where specified herein, joint and seam vapor sealant shall be water based materials equal to Foster 30-35, Hardcast “Flex-Grip” 550 (sprayed to 20 mil thickness), or Childers Chil-Perm WB CP-35.

2.5 All ductwork in the building and in the plant except return and exhaust ducts shall be insulated externally unless specifically excluded. Only sound attenuated return ducting may be insulated internally, if specifically designated as such.

2.6 Where ducts are lined internally, (see Drawings for Scope) no exterior insulation will be required, except where specifically stated otherwise. Where internal and external insulation join, they shall lap at least 24 inches.

2.7 Low pressure supply duct taps to ceiling diffusers shall be externally insulated including top of ceiling diffuser with 2" Insulation C.

2.8 Flexible round ducts are specified in Section 23 3100 as factory insulated.

2.9 FSK tape shall NOT be allowed.

2.10 Where ducts are lined internally, (see Drawings for Scope) no exterior insulation will be required, except where specifically stated otherwise. Where internal and external insulation join, they shall lap at least 24 inches.

2.11 Low pressure supply duct taps to ceiling diffusers shall be externally insulated including top of ceiling diffuser with 2" Insulation C.

2.12 Flexible round ducts are specified in Section 23 31 00 as factory insulated.

2.13 All kitchen hood exhaust ductwork connected to both inlet and discharge sides of Fans shall be insulated. Insulation shall be 1" insulation A.

2.14 INSULATION METAL JACKET

A. Jacket - .016”x 36” aluminum smooth with moister barrier jacket.

B. Jacket - .020” x 36” aluminum smooth with moister barrier jacket (High traffic areas.)

C. Aluminum fasteners – ¾” bands, ¾” wing seals .024 elbow covers.

D. T-304 stainless steel fasteners – ½” x .020 bands, ½” wing seals.

E. Screws are not to be used to secure jacketing

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.

2. Finish with fiberglass tape embedded in vapor barrier emulsion.

3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:

1. Provide with or without standard vapor barrier jacket.

2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. For ductwork exposed in mechanical equipment rooms or in finished spaces up to 8’ above finished floor, finish with aluminum jacket.

E. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

F. External Duct Insulation Application:

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive to match jacket.

2. Secure insulation without vapor barrier with staples, tape, or wires.

3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Duct and Plenum Liner Application:

1. Adhere insulation with adhesive for 100 percent coverage.

2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.

3. Seal and smooth joints.

4. Seal liner surface penetrations with adhesive.

5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

3.4 All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

3.5 All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

3.6 All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

3.7 Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

3.8 Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

3.9 Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

3.10 The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

3.11 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.12 DUCT INSULATION SCHEDULE:

Duct Type	Insulation Type
Mechanical Room Supply Round/Oval	1 1/2" Insulation A
Mechanical Room Supply Rectangular	1 1/2" Insulation B
Supply not in Mechanical Rooms	2" Insulation C
Outside Air	1 1/2" Insulation B
Kitchen Exhaust Air	2" 2-hour rate fire blanket as detailed or engineered system

Where ductwork is required to sit on an angle-iron trapeze hanger per specification 23 0529 and the duct is not in a mechanical room, type B insulation (or a piece of foamglass with thickness to provide the same thermal properties and a vapor barrier jacket) shall be used in no less than 6" lengths spanning the width of the duct, centered on the trapeze. This shall prevent compression of the insulation while maintaining a vapor barrier seal.

End of Section 23 0713

SECTION 23 0719
PIPING INSULATION

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. 23 0000 -- Basic Mechanical Requirements

B. 23 0529 -- Sleeves, Flashings, Supports and Anchors

C. 23 0553 -- Mechanical Identification

1.2 SECTION INCLUDES

A. Piping insulation

B. Jackets and accessories

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 22 1316 - Plumbing Piping: Placement of hangers and hanger inserts.

B. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.

1.4 RELATED SECTIONS

A. Section - Painting: Painting Insulation Jacket.

1.5 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded- Hot-Plate Apparatus.

C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

D. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal

F. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C547 - Mineral Fiber Preformed Pipe Insulation.

I. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

J. ASTM C578 - Preformed, Block Type Cellular Polystyrene Thermal Insulation.

K. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

L. ASTM C591 - Rigid Preformed Cellular Urethane Thermal Insulation.

M. ASTM C610 - Expanded Perlite Block and Pipe Thermal Insulation.

N. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

O. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

P. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).

Q. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.

R. ASTM E84 - Surface Burning Characteristics of Building Materials.

S. ASTM E96 - Water Vapor Transmission of Materials.

T. NFPA 255 - Surface Burning Characteristics of Building Materials.

U. UL 723 - Surface Burning Characteristics of Building Materials.

1.6 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Product Data: Provide product description, list of materials ‘k’ value, ‘R’ value, mean temperature rating, and thickness for each service, and locations.

C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.7 QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00.

C. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.

1.8 QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years experience specializing in the trade.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

C. All insulation materials to be asbestos free.

PART 2 PRODUCTS

2.1 DOMESTIC HOT AND COLD WATER WATER:

A. All domestic hot water lines in buildings, including valves, strainers, unions, flanges, etc., except where specifically noted to the contrary, shall be insulated. Domestic cold water in exterior walls shall also be insulated as hot water

B. All domestic cold water lines (PW, LCW, PW) & RO in in external walls only shall be insulated as scheduled with preformed fiberglass insulation with a factory applied All Service Jacket, vapor sealing all joints, and factory performed fittings with vapor seal, or a flexible, "25-50" rated, closed cell elastomeric thermal insulation such as "Self Seal Armaflex 2000". Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint. All elastomeric insulating products shall be guaranteed not to react with copper piping. Valves shall be insulated with mitered pipe covering with voids filled with glass fiber blanket insulation. Valves and fittings shall be vapor sealed with a water base asphaltic emulsion. Fittings on concealed insulation shall be built up to the thickness of adjacent insulation with glass fiber fitting wrap and shall be finished with Glasfab tape embedded in vapor barrier emulsion. Exposed fitting insulation shall be built up to same thickness as adjoining pipe insulation with one coat cement and after drying shall be finished with a white vapor seal and canvas jacket secured with "Arabol" adhesive and be suitable for painting. Seams in jacket shall be placed in the least noticeable locations. Where seams, joint or fittings are rough they shall be covered with an application of insulating cement troweled on smoothly before the canvas is applied with Arabol adhesive. The canvas must be free of wrinkles and have a smooth, neat appearance.

C. All domestic hot water water piping systems shall be insulated as specified above for cold water fiberglass except the vapor barrier may be deleted and the lap and butt joints secured with staples and a field applied adhesive (self sealing lap and butt joints alone are not acceptable). No closed cell elastomeric insulation shall be used on domestic hot water systems. The insulation thickness shall be as scheduled. Where service temperature exceeds 250°F, insulation shall contain high temp binders.

D. The only domestic hot and cold water piping that will not require insulation are the exposed runouts under non-handicap plumbing fixtures. Where pipe chases are tight, adequate provision shall be made at the rough in stage utilizing offset fittings or other means (except springing the pipe) to insure that insulation can be applied throughout the length of the pipe.

2.2 CHILLED WATER PIPING:

A. Chilled Water Piping - “FOAMGLAS” as manufactured by the Pittsburgh Corning Corporation Insulation and shall be installed on chilled water lines in buildings. The “FOAMGLAS” “StrataFab System” may also be installed on larger pipe sizes as appropriate. Prior to application of any insulation, all metal surfaces shall be thoroughly cleaned. The metal shall then be primed with an asphaltic primer consisting of one (1) coat of Foster No. 60-26 Primer or Pittcote 300 Primer. Cleaning and priming specified in this paragraph is not included in requirements for “Cleaning and Painting” specified in other sections of the Specifications. Regular “FOAMGLAS” insulation shall be applied to the piping with butt joints staggered and all joints tightly butted and sealed with a ¼” bead of joint sealer ½” from outside edge. Hold in place with 14 ga. copper clad wire 9” o.c. After insulation has been wired in place, a 1/16” minimum thick, 3” wide band of asphaltic vapor seal mastic shall be brushed or trowelled on the outside of the “FOAMGLAS” insulation at the approximate location of the aluminum bands. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) Any voids in “”the completed installation of the insulation shall not be filled with vapor seal coating but shall be eliminated by refitting or replacing insulation.

B. Chilled Water Piping Alternate: Insul-Phen as manufactured by Reolco or “KOOLPHEN K” as manufactured by Kooltherm. These materials shall be installed in strict compliance with the more stringent of these specifications or the manufacturer’s published installation manual which shall be available on site at all times. For cold water pipe all horizontal and circumferential joints shall be sealed with a very thin coat of vapor barrier mastic prior to closing the joints. All joints shall be staggered. The vapor barrier jacket shall be equal to Venture Wrap 1555W/U 3.4 mil, “0” perm cleanable material with 4” seam tape overlap and 6” joint tape or equal. Refer to the foamglass above for the method of insulating valves, fittings, etc. If Insulphen or Koolphen are used, an aluminum jacketing 0.016” thickness equal to Premetco precast will be required, pre rolled Z-lock Kraft paper lined pipe covering with zee type closure and ¾” wide snap straps with permanent sealant shall then be fitted to O.D. of insulation and applied over the insulated pipe with 4” end and side caps secured with aluminum bands on 12” centers. Longitudinal joint of aluminum jacketing shall be placed with overlap directed to bottom of pipe.

C. For cold water pipe, seal the ends of insulation and provide vapor dams at each end location or every 18’, which ever is shorter. Provide vapor dams between pipe and insulation at each flange, valve, change to vertical and end of insulation at equipment.

D. “FOAMGLAS”, “Insul-Phen” or “KOOLPHEN K” insulation on flanges, valves and other fitting shall consist of prefabricated fitting covers of the same thickness as specified for adjoining pipe insulation per the manufacturer’s published installation instructions.

E. Fitting covers shall be applied in same manner as pipe application except that 16 ga. aluminum wire may be used to secure fitting covers. Protruding metal parts (such as valve stems) shall be

completely sealed off. Fitting cover jacketing shall be equal to Gasco, Papco or RPR Metals prefabricated fitting covers of 0.016" paper coated aluminum, secured as recommended by the manufacturer.

F. The insulation thickness shall be as scheduled.

G. "FOAMGLAS" , Insul-Phen, or "KOOLPHEN K" installed inside the building (where ambient conditions are typically below 76°F and humidities are below 60% RH) shall be installed with factory applied Class I, Fire Rated, Kraft-Aluminum jacketing on for Insulphen and Koolphen install "0" perm jackets on cold water pipe, with 4" longitudinal laps and 6" joint tape. It shall be applied in strict accordance with the manufacturer's recommendations after the pipe has been primed with one (1) coat of Foster No. 60-26 Primer or Pittcoat 300 Primer. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) It will be necessary to include expansion joints at regular intervals on dual temperature service. Thickness shall be as scheduled.

H. Fitting covers shall be built up of shaped segments of "FOAMGLAS", Insul-Phen or "KOOLPHEN K". These fitting covers shall be adhered in place using "Foster No. 30-35 80" water based vapor seals, then smoothly covered by a one-quarter inch (1/4") thick application of one coat white insulating cement. All this piping and fittings shall be finished with an eight ounce canvas jacket neatly applied using Arabol adhesive.

I. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and premolded sections, plus white vapor seal mastic, plus Manville No. 301 finishing cement to smooth surfaces, plus canvas applied and sized for painting with fire resistant adhesive. In addition, all manufactured vapor barrier jacketing in mechanical rooms and finished spaces shall be finished with canvas applied and sized for painting with fire resistant adhesive.

J. No chilled water pipe supporting structures shall pierce the insulation except as anchor points as shown on the Drawings. At these points, the anchor member shall occur on the bottom of the piping to allow condensation to drain.

K. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings. Heavy density insulation shall be installed at every hanger and supported by pipe saddles as scheduled herein.

2.3 PROTECTIVE JACKETING:

A. Provide protective jacketing in mechanical rooms on all pipe under 8' above finished floor.

B. Insulation Metal Jacket

1. Jacket - .016"x 36" aluminum smooth with moister barrier jacket.

2. Jacket - .020" x 36" aluminum smooth with moister barrier jacket (High traffic areas.)

3. Aluminum fasteners – ¾" bands, ¾" wing seals .024 elbow covers.

4. T-304 stainless steel fasteners – ½" x .020 bands, ½" wing seals.

A. 5. Screws are not to be used to secure jacketing. In indoor applications, Proto Corp. LoSmoke PVC jacketing and fitting covers may be used. Material shall have 25/50 rating and shall be limited to piping systems operating at 140 degrees or below.

2.2 EXPANSION JOINTS

A. Where expansion bends occur in the lines, a two foot (2') double layer contraction joint shall be provided in the main line starting two feet from the end of the main line ells on both sides of the expansion loop. Contraction joints shall consist of two 1-1/2" thick x 24" long pipe covering cuts into 17-1/4" and 6" lengths to provide a ¾" space by 10-1/4". A slip joint mastic (Pittseal III) shall be placed between layers from the ¾" space provided on the inside layer to the ¾" space on the outside layer.

B. The ¾" space on inside layer shall be filled with mineral wool loose fill and the ¾" space on the outer layer shall also be filled with same loose fill and joint sealer pressed ½" deep into space for sealing (Pittseal III). Around the outside layer at the ¾" space, there shall be wrapped a 4" wide piece of glass fabric and sealed down with vapor seal mastic. On pipe sizes smaller than aforementioned, the same contraction joint shall be provided using one inch (1") thick "FOAMGLAS" or "KOOLPHEN K" pipe covering for the inner layer. On two inch (2") IPS, both inner and outer layer shall be 1" thick "FOAMGLAS" or "KOOLPHEN K".

C. The joint and vapor seal mastic shall be Pittsburgh Corning Corporation Pittcote 300. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.

D. The slip joint sealer shall be Pittsburgh Corning Corporation's Pittseal III.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions in the absence of specific instruction herein.

B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the "90°" position, with the seam lapped such that the lap is directed down.

C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature: Vapor barriers are required. The vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

1. Provide vapor barrier jackets, factory applied or field applied.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.

3. Finish with glass cloth and vapor barrier adhesive.

D. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

E. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

3. If PVC fitting covers are used they shall have 25/50 rating.

4. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

5. For hot piping conveying fluids over 140°F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

3.3 INSERTS, SUPPORTS and SHIELDS:

A. Application: Piping 3/4 inches diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for Insulated pipes 3/4” and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS	Metal Thickness	Lengths of Shield
up thru 2”	14 gauge	12”
thru 6”	12 gauge	16”
above 6”	10 gauge	20”

C. Insert Location: Between support shield and piping and under the finish jacket.

D. Insert Configuration: Minimum 2” inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

F. The shields at support points shall be secured with ½” x 0.016” stainless steel bands and seals.

G. Finish insulation at supports, protrusions, and interruptions.

H. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings.

I. In lieu of the above the following system of support may be used:

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft^3 Koolphen K Phenolic Foam material to withstand the bearing loads transmitted from the pipe to the support, it shall extend for at least 1" on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table 1.

3. Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1" thickness of 2.2 lbs/ft^3 standard insulation including FSK/ASJ vapor barrier.

3.4 Table 1 K Block Support Centers

Nominal Pipe Size	3/4	1	1 1/4	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24
Max support centers (feet) Sch 80 pipe filled with water covered with 1" of Standard Insulation	6.5	6.5	6.5	10	10	10	10	10	14	14	14	20	20	20	20	20
Metal Saddle Gauge (Galvanized Steel)	22	22	22	20	20	20	16	14	14	14	14	14	114	14	14	14
Length of K Block (inches)	6	6	6	6	6	6	6	9	9	9	9	9	9	12	12	12

1. The Insulation at supports shall be a Kooltherm K Block. K Blocks shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel 180^0 saddle bonded to the bottom section of the K Block, for all pipe sizes 1 1/2" and larger.

2. The vapor barrier shall be completed by the use of a FSK/ASJ overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

3. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval. e.g. Of the type Kooltherm Insulation products K Block. Ref:- Kooltherm sketch 106/2c for use with Roller or flat beam support.

4. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

B. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

C. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

D. For purpose of definition in this Specification: “concealed” areas are those areas which cannot be seen by the building occupants, and “exposed” areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

E. Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.

F. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140°F on the hot surfaces.

G. Special Protection: All insulated piping in the mechanical rooms within 8'-0" of the floor shall be encased in a protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

H. All exposed outdoor piping shall have metal jacket.

I. Fitting insulation shall be applied in same manner as pipe application. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Pabco or RPR Metals prefabricated fitting covers of 0.016" paper coated aluminum, secured as recommended by the manufacturer.

J. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and pre-molded sections as necessary.

K. No pipe supporting device (other than guides or anchors attached directly to the pipe) shall penetrate the insulation.

3.5 PAINTING:

A. All exposed insulation shall be prepared to receive painting specified under Painting Section.

B. The pipe primer shall be Pittsburgh Corning Corporation Pittcote 300.

3.6 Insulation 'R' Value Schedule (R = thickness / k)

	Oper Temp	'k' @ Mean	Min. R value for each Pipe Size				
Service	°F	Temp °F	1" & less	1-1/4" to 2"	2-1/2" to 4"	5" & 6"	8" & over
Hot (1)	105-140	.26 @ 100	3.8	3.8	5.8	5.8	5.8
Cold (2)	40-55	.25 @ 75	2.0	3.0	4.0	4.0	4.0

1. Domestic Hot Water
2. Ch. Wtr; Dom. cold wtr; Storm and overflow; Cold condensate

- Minimum 'R' does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.
- A minus 15 percent tolerance, on the insulation performance listed shall be permitted for manufacturers' standard insulation systems.
- No chilled water piping insulation shall be less than 2" thickness. No chilled water pipe insulation in exterior or unconditioned spaces or located outdoors shall be less than 3" thickness.

End of Section 23 0719

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS

PART 1 GENERAL

1.1 EXECUTIVE SUMMARY

A. The Control Systems shall be bid and contracted to the Mechanical Contractor.

B. All DDC controllers and control system components as described herein shall be provided or furnished by an HISD approved CS manufacturer and integrated into the respective, existing CMCS and shall be capable of receiving global programming modifications from the CMCS. Approved manufacturers are limited to Alerton, Automated Logic and Reliable Controls.

C. VFD's shall be provided as required under this section for all pump and air handling unit motors. VFD's shall be installed and wired by the Division 26 Electrical Contractor. All VFD's for fan coil units and unit ventilators shall be provided, installed and wired by the equipment manufacturer.

D. All control valves for applications shall be Belimo pressure independent characterized control valves (PICCV).

E. Balancing valves are not needed when using pressure independent characterized controls valves (PICCV).

F. CS design for increased energy efficiency shall be given high priority.

G. Humidity control will take priority over temperature control when rooms are vacant.

H. Valves shall be installed on the outside of unit ventilator and fan coil unit cabinets by the Mechanical Contractor.

I. Panels for UC's shall be mounted on the outside of all unit ventilators and fan coil units with three feet of wall clearance in front of them. No higher than 7 ft to the bottom of panel.

J. All temperature, humidity and CO2 sensors shall be located across the room from the unit.

K. Demand ventilation shall be implemented on unit ventilators, fan coil units and air handling units with CO2 sensors and outside air dampers

L. Dehumidification mode shall only be enabled when both cooling (CHW or DX) and heating (HW or Electric) are enabled and operable.

M. All inputs (BI's and AI's) and outputs (BO's and AO's) shown on points schedules shall be hardwired to the controllers.

N. The engineer of record shall only edit sequences and points list as applicable for the designed equipment. Sequences and points lists that do not apply to the project shall be noted as such by engineer for each project.

O. DDC control vendor shall furnish two laptops or tablets to HISD CFS-DDC controls department at completion of job. Said laptop/tablets shall meet HISD specifications provided by DDC controls department. Provide written verification from DDC control department that they are in receipt of said laptop/tablets.

P. Provide an overlay system to start and stop Variable Refrigerant Flow Systems. Provide BACnet interface to VRF system to enable HISD monitoring and control of individual room temperature, humidity and CO^2 levels and all system status, alarms and error codes.

1.2 DESCRIPTION

A. General: The control system (CS) shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Management level Ethernet network speed shall be 1Gbps and Automation level MSTP network speed shall be 76.8 Kbps. Each mechanical system and building floor plan shall be depicted on an operator workstation by point-and-click graphics. The preferred CS shall be reliable, easy tooperate, easy to maintain, energy efficient and affordable.

B. Purpose: The purpose of the CS is to operate a building's HVAC system in a manner that provides effective temperature and humidity control while minimizing energy consumption. This means a control strategy that employs reheat for humidity control only as a last resort.

C. A single web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser from all PC's connected to the network.

D. Operators shall be able to operate systems through the web browser interface and all graphical/data representations must appear identical, whether the user is on site or viewing via the web at a remote location. Standard Operator functions such as control point manipulation, manipulation and viewing of trends, schedules and alarms shall be performed through the web browser interface. Advanced technical functions such as DDC programming and network configuration may be performed either through the web browser interface or using an operator's workstation via a VPN connection. Access to these advanced technical features shall be limited to only users with factory certified technical training or those authorized by HISD.

E. Contractor shall provide its newest web-based software and software updates required for this project. Additionally the installing contractor shall provide all computer related components (BAS web server – reference specifications for hardware requirements) for the new software platform to function in a peer-to-peer environment. Portable tablets from a variety of different manufacturers shall be able to access the system utilizing one of the browsers specified above for full access and functionality with the system.

F. The system shall directly control HVAC equipment as specified in Sequences of Operation. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone.

G. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of set points, (i.e. chilled water, discharge air, etc.) using owner defined parameters during occupied operation. In addition to optimization, the system shall also be able to start and stop primary mechanical equipment based on zone occupancy and/or zone load conditions.

    1. System Scheduling. In addition to standard daily, weekly, exception and holiday schedules, the operator shall be able to make a single entry schedule at the highest level of the district, school site and/or building, and, with no further modification, be in control of all equipment within that area (district, school site or building). The intent of this single entry schedule function is to allow district personnel to initiate with little or no notice of a school, community, weather or disaster event, the full operation or full shut down of all building systems with no further operator intervention or local override.

    2. Automated Demand Response.

        a. System shall monitor building power consumption from building power meter pulse signals, from building feeder line watt transducer or current transformer, and/or submeter. In addition, the system shall have the full ability to accept and respond to an automated

web services-based signal from a utility, ESCO, and/or Independent System Operator (ISO) as an indication of a high demand condition.

b. When power consumption exceeds adjustable predetermined levels adjustable for time of day, or a high demand situation is indicated with the receipt of a web-based signal, the system shall automatically adjust zone setpoints, de-energize low-priority equipment, and takeother programmatic actions to reduce demand. When demand drops below predetermined levels, the system shall restore loads as specified.

c. Systems only able to provide initial demand response through the shutdown of primary equipment, affecting occupant comfort, air changes and indoor air quality, are unacceptable.

H. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, set points, trends, and alarms specified in Section 23 09 00 Sequences of Operation shall be BACnet objects.

I. System shall be provided with the Utility reporting software and equipment as specified in the sequence of operations.

J. Contractor shall provide as part of bid documentation a listing of specification subsection numbers and paragraphs with which they DO NOT COMPLY. Any deviation of any kind from this specification must be CLEARLY addressed in the contractors bid proposal documents allowing the owner/engineer to evaluate all deviations from the desired system features detailed in this specification.

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division 23 for mechanical equipment.

C. Division 26 for electrical, lighting, and fire alarm equipment.

D. The HISD MEP Design Guidelines.

E. HISD BACnet Six Digit Device Instance and IP Address Allocation Master.

THE CHILLER SECTION SHALL INCLUDE A BACNET INTERFACE TO BE PROVIDED, INSTALLED AND WIRED BY THE CHILLER MANUFACTURER. THE SWITCHGEAR SECTION SHALL INCLUDE A MODBUS INTERFACE TO BE PROVIDED, INSTALLED AND WIRED BY THE SWITCHGEAR MANUFACTURER. VENDOR SHALL PERFORM CALIBRATION AND PROVIDE EVIDENCE OF SAME WITH CLOSE OUT DOCUMENTATION.

THE VARIABLE FREQUENCY DRIVE SECTIONS SHALL BE PROVIDED UNDER THIS SECTION AND INSTALLED BY DIVISION 23 AND WIRED BY DIVISION 26.

1.4 SCOPE OF WORK

A. Provide a complete Control System (CS) turnkey installation as detailed in this section of these specifications. The CS shall be a native BACnet based system that is stand alone in all aspects except that it shall be remotely monitored and controlled from the HISD Central Monitoring and Control System (CMCS) utilizing the BACnet protocol over the HISD District wide area network. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2010, BACnet or latest revision. All workstations and controllers,

including unitary controllers, shall be native BACnet devices conforming to the latest version of the ASHRAE BACnet standard. System as specified in these documents shall include any and all software and hardware to support at least 50 simultaneous users. All contractors, subcontractors and vendors are to strictly adhere to HISD Design Guidelines. Prior written approval from HISD is required for any deviation from these guidelines.

B. The CS shall comprise the following components:

1. Communication Control Panels (CCP), based on BACnet standards to interface the School CS to the district wide CMCS.

2. Unitary Controllers (UC), based on BACnet standards.

3. CS Automation Level Network, base on BACnet standards.

4. Field instrumentation.

5. Automatic dampers (not furnished as part of a unit) and valves.

6. Actuators for automatic valves and dampers.

7. Communication, sequences of operation and optimization software.

8. All power supplies, interlocking and control relays, equipment enclosures, conduit, junction and mounting boxes, cabling and other components, materials and services required for a completed and fully operational turnkey CS installation meeting these specifications.

9. All software necessary for servicing CS controllers and other CS equipment.

C. Provide the following support for the CS facilities:

1. Warranty and service during the warranty period.

2. Submittals, samples and record documentation.

3. Comprehensive commissioning and testing of the CS.

4. Training services for the Owner and Operators.

5. Coordination with other site contractors.

6. Reporting to the General Contractor, the Architect and Engineer to ensure a well coordinated and timely execution of the Work.

D. The CS shall be remotely monitored by the HISD district wide CMCS using BACnet over IP through the existing CMCS. The newest version of server and web software shall be provided.

E. Furnish the following devices for installation by Division 23:

1. Temperature sensing thermowells.

2. Automatic dampers.

3. Pipe tap for insertion flowmeters.

4. Tapping, piping and 3/8” ball valve, fully installed for all wet differential pressure sensors.

5. Motorized control valves.

6. Water pressure sensors and switches with isolation valves.

7. Companion flanges for inline pipe mounted equipment.

8. Furnish UC and damper actuators for terminal units and fan coil units to the unit manufacturer for factory mounting. The Mechanical Contractor shall provide access doors, where required, for all control system components to ensure proper maintenance access.

F. 120 Vac power shall be provided by Division 26 at locations indicated on the Division 26 drawings. Review and verify that these locations are adequate for the proposed CS. Extend power from these locations to all devices, as necessary.

1.5 ABBREVIATIONS

AD - Automatic Damper
ARCNET - Attached Resource Computer Network
ANSI - American National Standards Institute
ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
BIBB - BACnet Interoperability Building Block
BBMD - BACnet Broadcast Management Device
CS - Remote school/building Control System
CCP - Communications Control Panel
CMCS - Central Monitoring and Control System
CPU - Central Processing Unit
DDC - Direct Digital Control
ECPAP - Expandable Central Plant Application Panel
FAS - Fire Alarm System
FCU - Fan Coil UnitFPTU - Fan Powered Terminal Unit
FSD - Fire / Smoke Damper
HMI - Human Machine Interface
HVAC - Heating, Ventilating and Air Conditioning
ICT - Information Communication Technology
IEEE - Institute of Electrical and Electronics Engineers
I/O - Input/Output
IP - Internet Protocol
ISA - Instrumentation Society of America
ISO - International Standards Organization
I/O - Input/Output
LAN - Local Area Network
LCD - Liquid Crystal Display
LED - Light Emitting Diode
MSTP - Master Slave or Token Passing
NEC - National Electrical Code
NEMA - National Electrical Manufacturers Association
OIW - Operator Interface Workstation
PC - Personal Computer
PICS - Protocol Implementation Conformance Statement
PIM - Process Interface Module
POT - Portable Operator Terminal
RAM - Random Access Memory

ROM	- Read Only Memory
RFI	- Radio Frequency Interference
RH	- Relative Humidity
SD	- Smoke Damper
SVGA	- Super Video Graphics Adapter
UC	- Unitary Controller
UDP	- User Datagram Protocol
UL	- Underwriters Laboratory
UV	- Unit Ventilator
VAV	- Variable Air Volume
VDU	- Video Display Unit
WAN	- Wide Area Network

1.6 OVERALL DISTRICT-WIDE CONTROL SYSTEM PHILOSOPHY

A. The following is a description of the overall CMCS philosophy that shall be applicable to the CMCS and all school CS. It is provided for the purpose of placing the work of the school CS contracts.

B. For the purpose of describing the CMCS system architecture it shall be divided into three layers:

1. Management Level:

a. A Wide Area Network (the HISD WAN), shall provide a means of interoperable communication between the CMCS and the school CS using BACnet/IP. This WAN is hereafter referred to as the Management Level Network. The Management Level Network shall provide a means by which the building systems throughout the HISD facilities can exchange data in the form of BACnet objects. The Management Level Network shall be BACnet/IP over 1Gbps Ethernet and shall be such that an operator with the required access level shall be able to undertake monitoring and control functions for any of the integrated CS building systems from any PC that communicates as a Thin Client with theterminal servers residing at the Management Level.

b. It shall be the responsibility of each CS contractor, to ensure that all system data and full English language descriptors for 100% of the hardware and software points is available at the Management Level Network. Each CS contractor shall provide comprehensive and complete documentation regarding the BIBB, address, controller type, databases and other pertinent information. The intent is that the CMCS shall be able to automatically read this data from the network using the BACnet automatic “find new objects” features.

c. The CMCS architecture shall be Thin Client or equivalent such that all applications software resides at the terminal servers and the entire HISD facilities are covered by a single software license regardless of the number of Personal Computers that are accessing the Management Level Network at any point in time.

d. CMCS applications software shall run on the terminal servers and software resident at the CMCS Operator Interface Workstations (OIW) shall be minimized. The terminal servers shall be installed at the HISD Central Control Room. The CMCS workstations, including the Portable Operator Workstations (POT), shall be Thin Clients operating through a Virtual Private Network (VPN). It shall be possible to add access from a remote location by modem and/or via the Web.

e. The Operator Interface Workstations (OIW) that serve the CMCS and CS shall be resident on the Management Level Network, not the CS. If an OIW is required within a school, the CMCS contractor shall provide it under a separate contract.

f. The Management Level Network communications, without exception, shall be BACnet/IP. It is intended that there be a single point of interface from a school CS and the Management Level Network (HISD WAN). If additional CCP's are required in a school due to Automation Level node quantities or limitations of CCP capabilities, the additional CCP's shall be provided under this contract as an extension of the Management Level Network within the school by the CS Contractor.

g. The demarcation point between the CMCS and the school CS shall be the CS CCP connection to the WAN data outlet within the school. The CS Contactor shall make the final terminations with supervision from HISD.

2. Automation Level:

a. The Communication Control Panels (CCP) shall be part of the CS. CCP shall be software programmable with native BACnet/IP to BACnet/MSTP (76.8 Kbps minimum) or BACnet/ARCNET (156Kbps) routers between the Management Level Network and the BACnet controllers on the Automation Level Network.

b. The Automation Level shall primarily include the DDC controllers that interface with the field sensors and final control elements. It is anticipated that there will be two types of DDC controllers within the CMCS architecture:

(i) Expandable Central Plant Application panels (ECPAP).

(ii) Unitary Controllers (UC).

c. ECPAP controllers shall be fully programmable controllers and shall have the ability to handle major types of equipment such as air handling units, chiller plants, heating plants, etc. The ECPAP shall be native BACnet controllers and shall be interfaced with the Management Level Network via the CCP. ECPAP controllers shall accept up to 8 expansion modules. Expansion modules shall have onboard HOA's and potentiometers.

d. UC shall be application specific or fully programmable controllers and shall be suitable for the monitoring and control of specific types of smaller equipment such as VAV terminal units and Fan Coil Units. UC shall be native BACnet controllers at the Automation Level.

e. All controllers shall be BACnet compliant to ANSI/ASHRAE Standard 135–2010 or latest revision.

f. The CS Automation Level Networks shall be BACnet using MSTP or ArcNet. No other protocols or network architecture shall be used.

g. Where interface to a third party controller is not BACnet compatible, the interface shall be via Modbus. Provide Modbus to BACnet converters as necessary to integrate the third party controller into the Automation Level Network. If Modbus controllers cannot be integrated into the Automation Level, they may be integrated directly to the CCP.

3. Field Level: The Field Level shall include the instrumentation interfaced to the Automation Level DDC controllers such as the temperature, humidity, level, pressure sensors and switches. It shall also include the final control elements such as the valve and damper actuators and the control relays.

1.7 WORK OF THE CS CONTRACTOR

A. The CS Contractor shall provide the mapping, storage, and reporting of the school CS monitoring and control objects into the CMCS and the preparation of data presentation for the CMCS Management Level Network. Provide all necessary documentation, BIBB information, as required for the integration of the CS monitoring and control functions into the CMCS.

B. The CS Contractor shall assure that device instance, BBMD and UDP assignment and the network design adheres to the HISD BACnet Device Instance and IP Address Allocation Master design standard. CS system shall communicate BACnet Annex J to the CMCS and support network speeds of 100 Mbps. CS system design shall support thermograph floor plans, standard alarms and consist of standard configurations for typical systems. The CS Contractor shall provide the following:

1. Provide and configure in the form of standard BACnet values, the following alarms to be displayed by the CMCS.

    a. Fan failure

    b. Smoke alarm (if required)

    c. Space temperature out of range

    d. Supply air temperature out of range

    e. Loss of communication alarm

    f. HVAC equipment common alarm (i.e.: if any point in a piece of equipment goes into alarm, an HVAC common alarm shall occur)

    g. Any other alarms as specified elsewhere herein

    h. HOA switch in hand alarm

2. Provide standard BACnet configuration and access for the following to be displayed by the CMCS using standard BACnet objects and values.

    a. Schedules

    b. Trendlogs

    c. Alarms

    d. Any other displays as specified elsewhere herein

3. Provide the following data to be displayed and integrated into the BACnet CMCS.

    a. Space temperature deviation from setpoint

    b. Current controlling setpoint for each control loop HVAC equipment common alarm (i.e.: if any point in a piece of equipment goes into alarm, an HVAC common alarm shall occur)

4. All CS system devices shall comply with BACnet Annex L Standardized Device

    a. Profiles for communication to the CMCS BACnet Operator Workstation (B-OWS).

        (1) Building Controller (B-BC)

        (2) Advanced Application Controllers (B-AAC)

(3) Application Specific Controllers (B-ASC)

(4) Smart Sensor (B-SS)

(5) Smart Actuators (B-ACT)

5. The CS system shall be designed to provide BACnet data communication per standard BACnet Interoperability Blocks (BIBBs) (Annex K, ASHRAE Standard 135-2010 BACnet). The CS system shall communicate with the CMCS to share data, alarm and notify events, schedule, trend, manage devices and manage the network per the following BIBBs as a minimum.

Data Sharing

DS-RP-A Read Property-Client User of Data From Device
DS-RP-B Read Property- Device Providing Data
DS-RPM-A Read Property Multiple-Client User of Data From Device
DS-RPM-B Read Property Multiple- Device Providing Data
DS-WP-A Write Property-Client User of Data From Device
DS-WP-B Write Property- Device Providing Data
DS-WPM-A Write Property-Client User of Data From Device
DS-WPM-B Write Property- Device Providing Data
DS-COV-B Change of Value- Device Providing Data

Alarm and Event Notification

AE-N-A Notification-Client User of Data From Device
AE-ACK-A Acknowledge-Client User of Data From Device
AE-INFO-A Information-Client User of Data From Device
AE-ESUM-A Event Enrollment Summary-Client User of Data From Device

Scheduling

SCHED-A Schedule-Client User of Data From Device

Trending

T-VMT-A Viewing and Modifying Trends-Client User of Data From Device
T-ATR-A Automated Trend Retrieval-Client User of Data From Device

Device and Network Management

DM-DDB-A Dynamic Device Binding-Client User of Data From Device
DM-DDB-B Dynamic Device Binding - Device Providing Data
DM-DOB-A Dynamic Object Binding -Client User of Data From Device
DM-DOB-B Dynamic Object Binding - Device Providing Data
DM-DCC-A Device Communication Control-Client User of Data From Device
DM-DCC-B Device Communication Control - Device Providing Data
DM-OCD-A Write Property-Client User of Data From Device
DM-TS-A Time Synchronization- Client User of Data From Device
DM-UTC-A UTC Time Synchronization- Client User of Data From Device
DM-RD-A Reinitialize Device- Client User of Data From DeviceDM-BR-A Backup and Restore- Client User of Data From Device

DM-PT-A Private Transfer- Client User of Data From Device
DM-PT-B Private Transfer- Device Providing Data
DM-R-A Restore- Client User of Data From Device
NM-CE-A Connection Establishment- Client User of Data From Device

6. All standardized BACnet objects and features shall be fully implemented including but not limited to the following:
    - Enter full alphanumeric descriptions of all object descriptions, object names, points and devices in each object, value and point.
    - Each hardware and pseudo point and value in the CS shall be fully BACnet implemented.
    - All alarms shall have full alphanumeric descriptors.
7. CS Contractor shall provide a complete and certified report of all CS network and data information. The report shall provide the following as a minimum.
    - All object descriptors and object names.
    - All device and network addresses and descriptors.
    - All hardware point addresses and descriptors.
    - All analog and binary values and descriptors.
    - All trendlogs and descriptors.
    - All alarms and descriptors.
8. Controllers for each type of controlled equipment shall be configured to one commonstandard. Therefore, controller point use is consistent and will allow for consistent graphic creation and presentation to the operator.
9. Provide review of the proposed CS, CCP, UC and Automation Level Network for the compatibility and integration capabilities at the shop drawing and submittal stage the project. Report to HISD on any concerns relating to compatibility or integration of the CS into the CMCS.
10. Integrate the CS into the CMCS to include but not limited to the following:
    a. Point monitoring and control
    b. Trending
    c. Alarm configuration and annunciation
    d. Reporting of real time and historical data
    e. Equipment scheduling
11. Provide the necessary integration, graphics and interface commissioning of the CS BACnet data into the BACnet CMCS.
12. Create a graphic for each specific piece of equipment, its associated sequence of operation graphic and all menu penetration/summary graphics. This equipment shall include as it pertains to the project the following:

a. Chilled Water Systems

b. Hot Water Systems

c. Air Handling Units

d. Dedicated Outside Air Handling Units

e. Rooftop Units

f. Split Systems

g. VAV Terminal Units

h. Exhaust Fans

i. Lighting Points

j. Misc. Points

13. Provide (1) dynamic thermographic floorplan for every facility at the building level. Provide area thermographic floorplans for each floor and section of the building which shall be pick-able from the building level floorplan. These floor plans shall allow an operator to immediately know which zones are deviating from the current setpoint based on color changes on a zone by zone basis. TheCS Contractor shall be provided Mechanical and Electrical AutoCad drawings at no additional cost to create floor plans, displaying building, area, or section level floorplans with only the numerical temperature values without dynamic color graphics on the front-end is unacceptable. All thermographs shall be visible via web interface as well as on the LAN.

14. Provide (1) mechanical equipment floor plan for every 4,000 square feet of floor space. This drawing is a second layer that enables the operator to view:

    a. Mechanical equipment layout including piping and ductwork

    b. Equipment location

    c. Wall sensors that display the current space temperature

    d. VAV boxes and associated space temperature sensors

    e. Room numbers, etc.

15. Provide capability for global modification of user definable parameters of all points shall be provided standard to the operation of the system. Global modification is defined as the mass adjustment of user definable parameters across a defined group, area, facility, campus, or network. Parameters shall included, but not be limited to temperature setpoint (VAV boxes, AHU Discharge, VAV AHU Static Pressure Setpoints ect), equipment start/stop, equipment status, valve output signal, vfd speed control signal, and damper position signal. User shall be able to lock the definable parameter to a set value, or adjust a setpoint to an operator adjustable value. This function shall be accomplished through the standard graphical user interface/workstation and is to be selectively applicable by the user to all controllers on the network, all controllers in a specific facility or all controllers in a specific zone within a specific facility.

16. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:

    a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."

    b. Programming Environment. Tool shall provide a full-screen, cursor-andmouse- driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.

    c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.

    d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

    e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

    f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.

    g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.

        (1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.

        (2) System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

1.8 CONTRACTOR QUALIFICATIONS

A. The CS Contractor shall:

1. Have a local staff in the Houston, Texas area of trained personnel capable of giving instructions and providing routine and emergency maintenance on the CS, all components and software/firmware and all other elements of the CS.

2. Have a proven record of experience in the supply and installation of equivalent BACnet systems over a minimum period of five years. Provide documentation of at least three and no more than six projects of equal or greater size and complexity, if so requested by the General Contractor or Owner.

3. Be a factory certified representative for the native BACnet CS manufacturer for design, installation, and maintenance of the proposed systems.

4. Have comprehensive local service, training and support facilities for the total CS as provided.

5. Maintain local, or have approved local contracted access to, supplies of essential expendable parts.

B. Subject to their complete compliance with all other provisions of Section 23 09 00 of these Contract Documents, the CS Contractor shall be one of the following two local CS companies providing controls from a manufacturer as indicated:

1. Open Tech - Alerton

2. ALC/UES - Automated Logic

3. Unify Energy Solutions – Reliable Controls

1.9 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for Allowances and related contractual requirements.

B. Refer to Section 23 00 00 for General Mechanical Provisions

C. Refer to Section 23 73 23 for Air Handling Unit Control Requirements

D. Refer to Section 23 36 13 for VAV Terminal Unit Control Requirements

E. Refer to Section 26 00 00 for General Electrical Provisions

F. Division 26 shall provide all conduit and wiring for 120 volts and above, such as power to control panels, 120v valve operators, VAV terminal units, power supplies, etc.

G. Switchgear manufacturer shall provide Modbus interface to BAS.

H. Fire alarm manufacturer shall provide contacts within 18 inches of Division 23 09 00 control panels for monitoring only of specified fire alarm devices, zones, etc.

1.10 ELECTRICAL POWER PROVISIONS

A. 120Vac power shall be provided under a separate contract by the Electrical Contractor.

Power fed from the normal power circuits will be provided at the following locations:

Power fed from the emergency power circuits will be provided at the following locations:

B. Normal power shall be provided to the UC serving fan powered terminal units via the control transformer provided with the unit.

C. Provide the necessary low voltage power to the UC provided that will serve VAV terminal units from the power sources indicated above. Provide step down transformers within panel enclosures. Provide all necessary fuses and circuit protection devices.

D. Power shall be provided to the dampers interlocked to fans via the control transformer provided with the motor starter.

E. All components of the CS shall be powered from the sources above. Provide final terminations from the locations indicated on the Division 23 Drawings.

F. The CS Contractor shall provide any additional power that is required as part of this contract. This shall include all conduit, cabling, circuit breakers, interfaces, etc.

1.11 SHOP DRAWINGS

A. The following information shall be included on the cover page for each shop drawing and equipment documentation submittal:

1. Project name.

2. Date.

3. Submittal number and re-submittal number, as appropriate.

4. Name and address of Consultant.

5. Name and address of General Contractor.

6. Name and address of CS Contractor.

7. Name and address of supplier or vendor, as appropriate.

8. Name of manufacturer.

9. Reference to the applicable Specification Section by name and number.

B. Shop drawings shall be CAD generated, minimum plot size of 8.5 x 11 inches. Drawings shall include diagrams, mounting instructions, installation procedures, equipment details and software descriptions for all aspects of the system to be installed. At minimum, the shop drawings shall include:

1. CS topology schematic.

2. CCP, UC and other panel layouts, including floor plan location and interconnection drawings.

3. Field instrumentation locations on floor plan drawings.

4. Schematic of systems indicating instrumentation locations.

5. Installation details.

6. Schedule of cabling including details of proposed cable types.

C. Equipment submittals shall include design, performance and installation details for all aspects of the system to be installed. At minimum, the equipment documentation submittals shall include:

1. Equipment technical data sheets with mounting and installation details.

2. The documentation shall include comprehensive and complete details of the BIBB and Automation Level documentation including address, associated controller type, etc. as required and for the interface to the CMCS.

3. Details of networks/communications equipment, cabling and protocols proposed.

4. Software specifications and descriptions including operating sequences.

5. Field sensor and instrumentation specification sheets.

6. Damper and actuator specification sheets.

7. Valves and actuator specification sheets.

8. Details of piping and/or tubing proposed

1.12 O&M MANUAL CONTENTS AND FORMAT

A. Provide O&M Manual with full information to allow matching products under future Contracts to products under this contract, and to allow HISD to operate, maintain and repair (for user-serviceable aspects) products, including trade names, model or type Numbers, color dimensions and other physical characteristics.

B. Format:

1. Produce on 8-1/2 x 11-inch pages, and bind in 3-ring/D binders with durable plastic covers.

2. Label binder covers with printed title “OPERATION AND MAINTENANCE MANUAL”, title of project, and subject matter and “Number _ of _” of binder when multiple binders are required.

3. Separate each “Part” with substantial dividers tabbed and titled by Part number.

C. Contents:

1. Table of Contents for each volume, naming each Part.

2. Part 1: Directory with name, address and telephone number of Designer, Contractor and Subcontractors and Suppliers for each Project Manual section.

3. Part 2: Operation and maintenance instructions, arranged by Project Manual Section number where practical and where not, by system. Include:

a. For finish materials, maintenance instructions prepared by manufacturers including recommended cleaning methods and materials and special precautions identifying detrimental agents.

b. HVAC, plumbing and electrical products, prepared by product manufacturer, including:

(i) Product design criteria, functions, normal operating characteristic and limiting conditions.

(ii) Installation, alignment, adjustment, checking instructions and troubleshooting guide.

(iii) Operating instructions for start-up, normal operation, regulation and control, normal shutdown and emergency shutdown.

(iv) Spare parts list for operating products, prepared by manufacturers including detailed drawings giving location of each maintainable part, lists of spares recommended for userservice inventory and nearest source of in-stock spares.

(v) Outline, cross-section and assembly drawings; engineering data and wiring diagrams

(vi) Test data and performance curves.

1.13 RECORD DOCUMENTATION

A. Provide Operators' Manuals with, at minimum, the following information:

1. Details of all features and functions available to the Operators.

2. Details of all alarm, diagnostic, error and other messages. Detail the Operator action to be taken for each instance.

3. Detail special programs provided and provide a complete programming instruction manual. Detail operation of all software applications.

4. Detailed list of the database for all installed devices.

5. Details of all data base management functions and features.

6. All details and descriptions shall be in a step by step format such that an Operator/ Manager would be able to undertake the respective actions solely on the basis of information provided in the manuals and drawings.

B. Provide hardware manuals which shall include, at minimum, the following:

1. Specifications, maintenance requirements and installation requirements for all hardware components.

2. Record drawings and schedules of the completed installation including locationof devices, mounting details, cabling details.

3. Operating sequences and interlocks.

4. Names and addresses of spare parts suppliers.

C. Record drawings shall be CAD generated and shall include, at minimum, the following:

1. Details required by the shop drawings.

2. Final locations and point ID for each monitored and controlled device.

D. In additional to the required hardcopies, provide a CD with all of the record documentation in PDF format and a CD(s) containing backup copies of all installed software and graphics.

E. Online As-built documentation. Contractor shall provide digital replications of as-builts that shall be accessible from each equipment graphic controlled or monitored by the BAS. Electronic documents which shall be accessible include:

1. Module Drawing.

a. Provide an electronic wiring diagram of each control module (as shown in submittal documentation). Diagram shall display wiring schematic and terminations to end devices.

b. Diagram shall display each input and output terminals and label those that are used for the control application.

c. Diagram shall display module type/name and network address.

d. The module drawing shall be a separate graphic that is selectable at the applicable location for the control program.

2. Equipment Schematic.

a. Provide an electronic equipment schematic for each piece of mechanical equipment. In the event there are multiple quantities of a specific piece of mechanical equipment (i.e. variable volume box) the electronic schematic shall be viewable from each of these instances.

b. The schematic shall display all mechanical equipment characterizes including fans, dampers, valves, sensors and other applicable control devices.

c. The schematic shall show wiring terminations to each control device as shown in the submittal and as-build documentation.

d. Control devices shall be labeled by a symbol that can easily be identified in a bill of material that is shown on this graphic. The bill of material shall show the device symbol, description, manufacture and part number.

3. Sequence of Operations.

a. The sequence of operations shall be viewable for each piece of mechanical equipment and be in a text format as shown in the as built documentation.

b. The sequence of operations shall be selectable at the applicable location for the control program.

4. Bill of Material.

a. Provide a bill of material that indicates specific manufacture, part number, part description and quantity of each device for all system components.

1.14 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide onsite or off-site service in a timely manner after failure notification to the contractor. The maximum acceptable response time to provide this service at the site shall be 4 hours, during normal working hours.

C. This warranty shall apply equally to both hardware and software.

PART 2 - PRODUCTS

2.1 MANAGEMENT LEVEL NETWORK

A. Extension of the Management Level Network shall meet, at minimum, the following requirements:

1. Ethernet TCP/IP network.

2. BACnet standards.

3. Cabling shall be Category 6 or higher quality and shall be tested and certified for 1 Gbps data transfer rate.

2.2 CS AUTOMATION LEVEL NETWORK

A. CS Automation Level LAN shall consist of only the following LAN's:

1. BACnet/MSTP (76.8 Kbps minimum) or BACnet/ARCNET (156Kbps)

2. BACnet.

3. Data transfer rate and data throughput as required to meet the alarm annunciation requirements.

4. Battery backup with lighting and surge protection. 500 VA minimum.

B. The failure of any node on the Automation Level LAN shall in no way affect the operation of the CS except to inhibit monitoring and control functions at the OIW for that node or any devices served by the failed node.

C. The failure of any node shall not inhibit the communication between remaining nodes.

2.3 COMMUNICATION CONTROL PANELS (CCP)

A. CCP shall be software programmable controllers on the primary Management Level Network and shall be a router between the BACnet/IP Management Level Network and the BACnet/MSTP (76.8 Kbps minimum) or BACnet/ARCNET (156Kbps) Automation Level Network.

B. Provide, at minimum, one CCP.

C. The CCP shall incorporate software as necessary to provide communications on the Management Level Network.

D. The failure of any CCP shall be annunciated as an alarm at the CMCS.

E. Provide a real-time hardware clock at each CCP. The hardware real-time clock shall be used to synchronize all other hardware and software clocks in the CS.

F. Supply and install surge protection on all power and communication lines.

G. Install adequate battery back-up.

2.4 EXPANDABLE CENTRAL PLANT APPLICATION CONTROLLERS (ECPAC)

A. General

1. Expandable application controller shall be capable of implementing control strategies for the system based on information from any or all connected inputs. The program that implements these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site via simple download are not acceptable. Changing global strategies via firmware changes is also unacceptable. Program execution of controller shall be a minimum of once per second.

2. Programming shall be object-oriented using control program blocks. Controller shall support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value shall support standard BACnet priority arrays. Programming tool shall be provided with system and shall be the same tool that is used to program the Building Controller. All flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary.

3. Provide means to graphically view inputs and outputs to each program block inreal-time as program is executing. This function may be performed via the operator's terminal or field computer.

4. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field replaceable (non-rechargeable) lithium type. Unused battery life shall be 10 years.

5. The onboard, battery-backed real time clock must support schedule operations and trend logs.

6. Global control algorithms and automated control functions should execute via 32-bit processor.

7. Controller shall include both on-board 10BASE-T/100BASE-TX Ethernet BACnet communication over twisted pair cable (UTP) and shall include BACnet IP communication. In addition, controller shall include BACnet PTP connection port.

8. The base unit of the controller shall host up to 8 expansion modules with various I/O combinations. These inputs and outputs shall include universal 10-bit inputs, binary triac outputs, and 8-bit switch selectable analog outputs (0-10V or 0-20 mA). Inputs shall support 3K and 10K thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.

9. All outputs must have onboard Hand-Off-Auto switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

10. The position of each and every HOA switch shall be available system wide as a BACnet object. Expandable Central Plant Controller shall provide up to 176 discreet inputs/outputs per base unit.

B. BACnet Conformance

1. Central Plant/AHU Controller shall as a minimum support Point-to-Point (PTP), MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Building controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:

   a. Clock Functional Group

   b. Files Functional Group

   c. Reinitialize Functional Group

   d. Device Communications Functional Group

   e. Event Initiation Functional Group

2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include as a minimum: Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event

Enrollment, Notification Class, Program and Schedule object types. All necessary tools shall be supplied for working with proprietary information.

4. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

C. Schedules1. Each Central Plant/AHU controller shall support a minimum of 50 BACnetSchedule Objects.

D. Logging Capabilities

1. Each controller shall support a minimum of 200 trend logs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long term archiving if desired.

3. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

E. Alarm Generation

1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.

3. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

2.5 UNITARY CONTROLLERS

A. The CS Contractor shall provide all Unitary Controllers (UC). UC shall be fully programmable or applications specific controllers with pre-packaged operating sequences maintained in EEPROM or flash RAM.

B. The UC shall be a node on one of the Automation LANs and shall control its own communications so that the failure of any one node, shall not inhibit communications on the network between the remaining nodes.

C. UC shall be totally independent of other LAN nodes for their monitoring and control functions.

D. Provide each UC with a battery back-up or EEPROM for the protection of volatile memory for a minimum of 72 hours. Batteries shall be rated for a seven year life.

E. All associated applications programs shall reside at the UC. UC shall not require communication to any other panel for normal operating sequences other than time scheduled base commands.

F. Control shall be based on either three term algorithms, i.e. proportional plus integral plus derivative, or two term algorithms, i.e. proportional plus integral, unless specified otherwise.

G. Provide with each controller the BACnet configuration information including BIBB, address, controller configuration type, etc. to integrate the controller into the CMCS.

2.6 UNITARY CONTROLLER - TERMINAL UNITS

A. The CS Contractor shall provide all UC's required for all terminal units. The number and location of terminal units and air flow rates shall be as indicated on the Mechanical Drawings.

B. The terminal unit manufacturer shall provide the following components for each fan powered terminal unit for interface and mounting of the UC:

1. Primary air dampers to be controlled by the UC.

2. Enclosure to house the UC and associated components including suitable mounting brackets shall be NEMA 1 rating and located outside the terminal unit. The enclosure shall be lockable with the same keys used on the CCP's. Outside equipment shall have NEMA 4X enclosures that are waterproof.

3. Multi-point averaging type flow sensor at the primary air inlet to the terminal unit.

4. 24 VAC control transformer

5. 24 VAC fan control relay interface.

6. 24 VAC heater control relay interface (up to two stages).

C. The terminal unit manufacturer shall provide the following components for each cooling only VAV terminal unit for interface and mounting of the UC:

1. Primary air dampers to be controlled by the UC.

2. Enclosure to house the UC and associated components or suitable mounting brackets within the terminal unit enclosure.

3. Multi-point averaging type flow sensor at the primary air inlet to the terminal unit.

4. 24 VAC control transformer.

D. The CS Contractor shall furnish the terminal unit manufacturer the following components for factory installation and wiring for each terminal unit:

1. UC.

2. Damper actuator.

3. Discharge air sensor

E. The CS Contractor shall field install the following components for each terminal unit:

1. Room temperature sensor

2. Occupancy sensor (As shown on drawings or in points list)

3. CO2 Sensor. (As shown on drawings or in points list)

F. Provide integral differential pressure transducers for the monitoring of the terminal unit primary air flow rate.

G. Furnish primary damper actuators, for factory mounting, meeting the following requirements:

1. Direct shaft mounting.
2. Adequate torque, to properly operate the damper from fully open to fully closed without binding.
3. Locking “V” groove or similar means to prevent slippage between actuator and shaft.

H. The UC shall monitor and control the following parameters for fan powered terminal units:

1. Space temperature.
2. Primary air flow rate.
3. Damper modulation.
4. Heating coil stage control or heating valve control (as applicable).
5. Fan on/off control.
6. Discharge air sensor.
7. Occupancy senor (As shown on drawings or in points list)
8. CO2 Sensor. (As shown on drawings or in points list)

I. The UC shall monitor and control the following parameters for VAV terminal units:

1. Space temperature.
2. Primary air flow rate.
3. Damper modulation.
4. Discharge air sensor.
5. Occupancy sensor (As shown on drawings or in points list)
6. CO2 Sensor. (As shown on drawings or in points list)

J. PID algorithms shall maintain the system operation within + or - 1.0 Deg. F. of the space temperature setpoints.

K. Following the installation of the terminal unit in the ceiling space the CS Contractor shall undertake the following tasks:

1. Physically connect the UC into the CS Automation Level Network.
2. Install all data into the UC as necessary for the correct operation of the terminal unit.
3. Calibrate the instrumentation associated with the following monitored parameters:
    a. Space temperature.
    b. Primary air flow rate sensor. c. Discharge air sensor

4. Verify that the UC modulates the primary air duct dampers from fully open to fully closed and vice versa within the specified time and verify either visually or by feel that the damper closes fully under UC control.

5. Verify that each of the heating stages or valve cycles on and off (as applicable).

6. Verify that the terminal unit-UC is satisfactorily integrated into the Automation Level Network.

7. Verify that the operating sequences are correct and that there is stable modulation of the primary air damper and staging of the heat.

8. Assist the Air Balancing Contractor as required for the complete commissioning, calibration and operational verification of the HVAC and terminal unit systems.

2.7 UNITARY CONTROLLER – UNIT VENTILATORS (UV) AND FAN COIL UNITS (FCU)

A. The CS Contractor shall provide all UC's required for all unit ventilators (UV's) and fan coil units (FCU's). The number and location of UV's and FCU's and air flow rates shall be as indicated on the Mechanical Drawings.

B. Provide an enclosure to house the UC and associated components including suitable mounting brackets shall be NEMA 1 rated and located outside the UV's and FCU's.

C. The UC shall monitor and control the following parameters for UV's and FCU's:

1. Space temperature.

2. Space RH sensor

3. Cooling coil stage control or cooling valve control (as applicable).

4. Heating coil stage control or heating valve control (as applicable).

5. Fan on/off control.

6. Fan status

7. Discharge air sensor.

8. Occupancy sensor

9. Space CO2 sensor (As shown on drawings or in points list)

D. PID algorithms shall maintain the system operation within + or - 1.0 Deg. F. of the space temperature setpoints.

E. Following the installation of the UV's and FCU's in the ceiling space the CS Contractor shall undertake the following tasks:

1. Physically connect the UC into the CS Automation Level Network.

2. Install all data into the UC as necessary for the correct operation of the UV's and FCU's

3. Calibrate the instrumentation associated with the following monitored parameters:

a. Space temperature.

b. Space RH sensor

c. Discharge air sensor

d. Space CO2 sensor (As shown on drawings or in points list)

4. Verify that each of the heating stages or valve cycles on and off (as applicable).

5. Verify that the UV's and FCU's -UC is satisfactorily integrated into the Automation Level Network.

6. Assist the Air Balancing Contractor as required for the complete commissioning, calibration and operational verification of the HVAC and UV's and FCU's.

2.8 INTERFACE SOFTWARE

A. Alarms shall be generated by the CS upon the occurrence of one of the following events:

1. Failure of a CCP, UC, or any other CS hardware components.

2. Failure of communications of devices on the Automation Level Network.

3. A monitored status indicates a discrepancy between the actual and the required value.

4. A monitored value does not meet criteria established by the operator.

5. The deviation of a variable from setpoint exceeds operator established criteria.

6. The output to a final control element is outside operator established criteria.

7. A digital input is in the state defined by the operator as indicating an alarm condition.

8. Software failures and errors shall be diagnosed and annunciated by the CS. Provide configuration of alarming for all monitored and controlled points. Coordinate all alarm limits and definitions with HISD.

2.9 ENERGY MANAGEMENT SOFTWARE

A. An operator with CS configuration software shall be able to define a minimum time delay between successive starts of equipment so that disturbances created on the building electrical system are minimized in frequency and amplitude.

B. An operator with CS configuration software shall be able to define the minimum time delay between the stopping of a piece of equipment and its subsequent restart. This time delay shall be in effect for motors in the CS software control mode and for motors in the CS manual control mode.

C. The CS shall not override any hardwired interlocks such as those provided at motor starters for overload protection, damper interlock, pressure interlock, etc. and those provided to facilitate control by the Fire Alarm System regardless of the CS output control mode.

D. Unless stated otherwise elsewhere in these Specifications, the modulation of final control elements by the CS in the CS software control mode shall be based on a Proportional- Integral-Derivative (PID) control algorithm. The control constants for the PID algorithm shall be definable by the operator. If self-tuning algorithms are provided, it shall still be possible for the operator to manually tune the control loops. The software shall incorporate facilities to enable the bumpless transfer of a modulating output from CS manual control to CS software control and vice versa and the prevention of integral windup. PID algorithms shall maintain the system operation within the desired tolerance around the setpoint.

E. Provide dynamic graphical trending software that emulates, at minimum, a three point strip graphical format. The graphs shall be plotted as the values are sampled in a similar fashion to a chart recorder and when the plot reaches the right hand side of the X-axis, the X-axis shall scroll to the left so as to accommodate newly sampled data.

F. Provide an energy monitoring software facility to monitor and report electrical energy usage and instantaneous energy demand. This feature shall also store data for recall via the historical data trend package.

G. Provide run time totalizing software that will accumulate the operating times for motors and unitary equipment as selected by the operator using an interactive procedure. Any piece of equipment that has its status monitored by the CS shall be selectable for inclusion in this feature. It shall be possible to concurrently monitor the accumulated operating time for every item of equipment monitored and/or controlled by the CS.

H. Provide demand limiting and duty cycle programs that will duty cycle equipment usage in a manner that conserves energy. The cycling of equipment shall be initiated by one of the following means:

1. Operator defined schedule.

2. Peak electric demand control software program.

3. Operator manual command.

The proportion of ON time to OFF time in a single cycle shall either be assigned by the operator using an interactive procedure or the operator may elect to have a variable ON/OFF ratio based on other criteria.

I. Provide a scheduling program that will enable the CS to automatically schedule an item of equipment on and off (occupied) and on and off (unoccupied) based on time to allow the AHU to operate with the outside air dampers closed during non-occupied time periods. The operator shall be able to assign a minimum of four start and four stop times to each piece of equipment for each day of the week and for holidays. These schedules shall only be in effect for a piece of equipment when it is in the CS software control mode. The scheduling feature shall conform to the requirements of the CMCS scheduling interface.

J. Provide equipment fail restart software that will restart equipment shut down as the result of a signal provided by the fire alarm system following the return to normal conditions or a power fail condition.

K. Provide a night setback software program that shall:

1. Start HVAC equipment after normal hours of scheduled operation to maintain building after hour setpoints, while reducing energy consumption.

2. Night setback temperatures for heating shall be initially set at 55° Deg. F.(adj.) to activate the heating equipment and 60° Deg. F. (adj.) to stop the heating equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.

3. Night setup temperatures for cooling shall be initially set at 90° Deg. F. (adj.) to activate the cooling equipment and 85° Deg. F. (adj.) to stop the cooling equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.

4. This feature shall be provided for all HVAC equipment under control of the CS. The operator shall be able to enable/disable this function on a unit by unit basis.

L. Global modification of user definable parameters of all points shall be provided standard to the operation of the system. Global modification is defined as the mass adjustment of user definable parameters across a defined group, area, facility, campus, or network. Parameters shall included, but not be limited to temperature setpoint (VAV boxes, AHU Discharge, VAV AHU Static Pressure Setpoints ect), equipment start/stop, equipment status, valve output signal, vfd speed control signal, and damper position signal. User shall be able to lock the definable parameter to a set value, or adjust a setpoint to an operator adjustable value. This function shall be accomplished through the standard graphical user interface/workstations.

2.10 AUTOMATIC DAMPERS

A. Furnish automatic dampers (AD) as indicated on the Division 23 Mechanical Drawings for installation by the Division 23 Mechanical Contractor. Refer to Division 23 Drawings.

B. Provide actuators for all automatic dampers furnished as part of the CS contract. Provide all required actuator mountings, installation, drive arms, linkages and damper end switches. Provide actuators for all dampers provided as part of a factory installation within AHU or unit ventilators.

C. Dampers and actuators shall be configured for normal and failure positions as indicated in the operating sequences and as indicated in the Division 23 Mechanical Drawings.

D. The maximum leakage rate for AD shall not exceed 10 cfm per square foot at 4 inches W.C.

E. Provide electric damper actuators for all AD. Electric actuators shall meet, at minimum, the following requirements:

1. Actuators shall be directly coupled to damper drive blades with no intermediate linkages or shall be rotary type actuators directly coupled to the damper drive shaft.

2. 120 Vac + or - 10% 60 Hz or 24 Vac power supply.

3. Actuators shall be motorized/driven in both the open and closed directions.

4. Where required by the sequences of operation, actuators shall have a spring return to the de-energized position upon loss of power. Damper normal and failure positions shall be as identified within the sequences of operation.

F. Damper actuators shall be Belimo.

2.11 CONTROL VALVES

A. Furnish all valves controlled by the CS as detailed in the Mechanical Documents and as indicated in the Point Sheets. Furnish all shut-off valves for instrumentation. All other valves such as check valves, relief valves, pressure reducing valves, self regulating valves, manually operated valves, etc. shall be furnished and installed by the Mechanical.

B. Refer to the Division 23 plans and drawings for the design conditions on which to base sizing and ratings of the valves and their actuators.

C. All chilled water, condenser water, and hot water valves shall meet, at minimum, the following ANSI Class 150 ratings.

D. Valves 0.5 inch to 2 inches shall have NPT female screwed ends. Valves 2.5 inches and larger shall have flanged ends.

E. Verify and certify that the materials of construction of the pipe, weld, flange, bolts and valve will not cause any galvanic corrosion.

F. Where necessary to achieve the required performance and pressure drop a control valve may be down sized up to two nominal sizes below line size. Two position valves shall be full line size.

G. Valves shall be installed on the outside of unit ventilator and fan coil unit cabinets by the Mechanical 23 Contractor.

H. Control Valves ½" to 6": The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The Mechanical Contractor shall install all valves. Equal Percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves 2½ inches and above.

1. Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

2. Pressure Independent Characterized Control Valves (PICCV)

a. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

b. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.

c. Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve.

d. Flow Characteristics: Equal percentage characteristics.

e. Close-Off Pressure Rating: NPS 2 and Smaller, 200psi. NPS 2-1/2 and up, 100psi.

f. All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.

g. The manufacturer shall provide a published commissioning procedure that follows the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

h. The pressure independent control valve shall be provided and delivered from a single manufacturer as a complete assembly. The actuator shall be integrally mounted to the valve at the factory with a single screw on adirect coupled DIN mounting-base.

i. The control valve shall require no maintenance and shall not include replaceable cartridges.

j. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

k. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing

the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.

l. Valves shall be Belimo or approved equal

3. Globe Valves

a. Provide globe valves where a PICCV will not meet the performance requirements of the application.

b. Valves 2-1/2 inch (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (.1%) close-off leakage at 50 psi differential.

c. Valves with spring return actuators shall close off against 120% of system psi pressure differential with Class III leakage (.1%).

d. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.

e. Mixing and diverting valves must be installed specific to the valve design.

f. Valves shall be Belimo.

I. Provide butterfly valves at the following locations:

1. Cooling tower bypass.

2. Chilled water bypass. The fully modulating chilled water bypass valve shall be sized to accommodate the minimum flow of one chiller in operation. The minimum flow (GPM) of the chiller will be determined by the chiller manufacturer. Chilled water pipe on the entering and leaving side of the bypass valve shall be sized to carry the full GPM of the minimum flow of the chiller. There shall be a minimum of 3' of straight pipe on the entering and leaving side of the bypass valve, not including the distance that the isolation valves takes up. Isolation valves shall be installed on both sides of the bypass valve.

J. Butterfly valves shall meet, at minimum, the following requirements:

1. Full lugged type. Semi-lug and wafer valves are not acceptable.

2. Valves shall be full line size.

3. Stem shall be stainless steel and extended for insulation.

4. Valves shall be Belimo.

K. Provide electric actuators for all control valves that are furnished as part of the CS contract. Two way and three way control valve actuators shall meet, at minimum, the following requirements:

1. Motor driven type.

2. Gear assembly shall be made of hardened steel. No plastic components shall be acceptable.

3. Actuator shall have an input voltage of 24 VAC or 120 VAC for larger butterfly valves.

4. Exterior housings shall be NEMA-4 rated.

5. Sized to meet the shut-off requirements when operating at the maximum system differential pressure and with the installed system pump operating at shut-off head. Actuators shall control against system maximum working pressures.

6. Normal and failure positions shall be as indicated in the Operating Sequences. Provide spring return actions as necessary.

7. Visual mechanical position indication, showing valve position.

8. Equipped with an integral position potentiometer to indicate the stem position of the valve if required by the sequence of operation.

9. Manual declutch lever to enable manual operation of the valve. It shall be possible for an operator to manually modulate valves located in mechanical rooms in the event of loss of power.

10. Electric actuators shall be Belimo.

2.12 FIELD INSTRUMENTATION

A. Outside air temperature sensor: Provide outside air temperature sensors as indicated within the Point Schedules. Temperature sensors shall meet, at minimum, the following requirements:

1. Ventilated white PVC sun shield.

2. Wall mount weather proof enclosure with conduit fitting.

3. RTD or thermistor.

4. CS shall report the monitored temperature with an end-to-end accuracy of ± 0.5 Deg. F.

B. Duct mounted temperature sensor: Provide duct mounted, single point temperature sensors as indicated within the Point Schedules. Temperature sensors shall meet, at minimum, the following requirements:

1. Averaging sensor on air handler applications.

2. Duct probe sensor on terminal unit and unit ventilator applications.

3. Stainless steel.

4. RTD or thermistor.

5. CS shall report the monitored temperature with an end-to-end accuracy of ± 0.5 Deg. F.

6. Provide with a galvanized box. Plastic boxes are not allowed.

C. Wall mounted space temperature sensor: Provide wall mounted temperature sensors for spaces as indicated within the Point Schedules. Temperature sensors shall meet, at minimum, the following requirements:

1. Location as shown on the Mechanical Drawings. Sensor location shall be across the room from the unit.

2. RTD or thermistor.

3. CS shall report the monitored temperature with an end-to-end accuracy of ± 0.5 Deg. F.

4. Mounted 48 inches above finished floor or adjacent to light switch. Mount even with top of light switch across the room from the unit.

5. Setpoint adjustment slide bar

6. Provide an editable pushbutton override to each common areas listed. Student Dining Commons, learning commons, gyms, auditorium or multipurpose room & administration office for cooling/heating during after hours activities.

    a. They shall be housed in a panel installed by CS contractor & shall be locked with a standard key the CS contractor uses on his projects.

    b. One panel shall be in the administration office for the Student Dining Commons, learning commons, auditorium or multipurpose room & administration office with an editable pushbutton for each area.

    c. one panel shall be placed in a common area of the gym with an editable pushbutton. The associated locker room for each gym shall be on the gym override. If more than one gym there shall be an editable pushbutton for each one.

    d. Label pushbutton for each area they serve.

7. Provide flat plate stainless steel sensors with no local setpoint adjustment in corridors, gymnasiums and common areas.

D. Thermowell temperature sensor: Provide thermowell mounted temperature sensors as indicated within the Point Schedules. Temperature sensors shall meet, at minimum, the following requirements:

1. Rigid stainless steel probe of length which is, at minimum, 20% of the pipe width. 2. RTD or thermistor.

2. CS shall report the monitored temperature with an end-to-end accuracy of ± 0.25 Deg. F. accuracy.

3. Moisture/waterproof housing with conduit fitting.

4. Stainless steel thermowell.

5. Provided with thermal conductivity grease to aid temperature sensing.

6. Galvanized or plastic boxes are not allowed.

E. Freezestat: Provide freezestats for all air handling systems that receive untreated outside air. Freezestats shall meet, at minimum, the following requirements:

1. Provide vapor tension elements, which shall serpentine the inlet face on all coils. Provide additional sensors, wired in series, to provide one linear foot per square foot of coil surface area.

2. Interlock to the associated fan so that fan will shut down when HOA switch is in Hand or Auto position. Provide time delay relays with a 0-10 minute time delay relay duration to minimize nuisance freezestat trips. Time delay relay shall be adjustable at the associated control panel.

3. Automatic reset. Shall be reset through software.

F. Outside air relative humidity sensor: Provide outside air relative humidity sensors as indicated within the Point Schedules. Humidity sensors shall meet, at minimum, the following requirements:

1. Non-corroding outdoor shield to minimize wind effects and solar heating. Wall mount weather proof enclosure with conduit fitting.

2. Two wire, 4-20 mA output proportional to relative humidity range of 0% to 100%.

3. ± 2% accuracy (5 - 95% RH).

4. Humidity sensor shall be replaceable.

G. Interior air relative humidity sensor: Provide wall mounted relative humidity sensors as indicated within the Point Schedules. Humidity sensors shall meet, at minimum, the following requirements:

1. Wall mount enclosure with white cover.

2. Two wire, 4-20 mA output or digitally communicating proportional to relative humidity range of 0% to 100%.

3. Humidity sensor shall be replaceable.

4. ± 2% accuracy (5 - 95% RH).

5. Mounted 48 inches above floor across the room from the unit.

H. Duct mounted relative humidity sensor: Provide duct mounted relative humidity sensors as indicated within the Point Schedules. Humidity sensors shall meet, at minimum, the following requirements:

1. Duct mounted moisture resistant enclosure with conduit fitting.

2. Two wire, 4-20 mA output proportional to relative humidity range of 0% to 100%.

3. Humidity sensor shall be replaceable.

4. ± 2% accuracy (5 - 95% RH).

5. 8 inch probe length.

I. Wall Mounted Carbon Dioxide Sensor: The CO2 sensor shall be capable of monitoring CO2 concentration in a space at an accuracy of +/- 30 parts per million (PPM). The CO2 sensor shall produce a linear 0-10 VDC signal over the range of 0 to 2000 PPM. The CO2 sensor shall measure using non-dispersed infrared (NDIR) technology to measure carbon dioxide gas and shall have Automatic Background Calibration (ABC) algorithm to reduce typical zero-drift check maintenance. CO2 sensors for unit ventilators and fan coil units shall be mounted across the room from the unit beside the wall mounted space sensor. Wall mounted carbon dioxide sensors shall be Honeywell C7632A or Veris CW LSXX.

J. Duct Mounted Carbon Dioxide Sensor: The CO2 sensor shall be capable of monitoring CO2 concentration in a space at an accuracy of +/- 30 parts per million (PPM). The CO2 sensor shall produce a linear 0-10 VDC signal over the range of 0 to2000 PPM. The CO2 sensor shall measure using non-dispersed infrared (NDIR) technology to measure carbon dioxide gas and shall have Automatic Background Calibration (ABC) algorithm to reduce typical zero-drift check maintenance. CO2 sensors for duct mounted applications shall be installed in the return air path. Duct mounted carbon dioxide sensors shall be Honeywell C7632B or Veris CW LSXX.

K. Momentary control relays: Provide momentary control relays as indicated within the Point Schedules and sequences of operation. Relays shall meet, at minimum, the following requirements:

1. Coil ratings of 120 VAC, 50 mA or 10-30 VAC/VDC, 40 mA as suitable for the application.
2. Provide complete isolation between the control circuit and the digital output.
3. Located in the UC or other local enclosures.
4. 10 amp contact rating.
5. LED status indication.
6. Pin type terminals.
7. Latching relays not acceptable.

L. Duct static pressure sensor: Provide duct mounted static pressure sensors as indicated within the Point Schedules. Static pressure sensors shall meet, at minimum, the following requirements:

1. Input range shall be 0 to 2.0 inches w.g. or as required by the application.
2. 4-20 mA output proportional to pressure input range.
3. ± 5% accuracy.

M. Current sensing relay: Provide current sensing relays as indicated in the Point Schedules for motor status. Current metering transformers and relays shall meet, at minimum, the following specifications:

1. Rated for the applicable load.
2. The output relay shall have an accessible trip adjustment over its complete operating range. Provide LED indication of relay status.
3. Split core shall be sized for the application.
4. Latching relays not acceptable.

N. Water differential pressure sensor: Provide water differential pressure sensors as indicated in the Point Schedules. Water differential pressure sensors shall meet, at minimum, the following requirements:

1. Cast aluminum NEMA 1 enclosure.
2. Output of 4-20 mA or 0-10 vdc proportional to the pressure sensed.
3. Operating range of 0 to 30 psig.
4. Accuracy of ± 2% of full scale reading.
5. Valved tappings shall be installed by the Mechanical Contractor.

O. Air differential pressure switch for fan shutdown: Provide air differential pressure switches as indicated in the Point Schedules to shut down the associated fan in the event of sensing high differential pressure. Air differential pressure switches shall meet, at minimum, the following requirements:

1. Adjustable setpoint with a setpoint range of 0 to 10 inches w.g.

2. 1/4 inch compression fittings suitable for copper sensing tubing.

3. Automatic reset. Shall be reset through software.

P. Photocell: Provide ambient light level sensors as indicated within the Point Schedules. Light level sensor shall meet, at minimum, the following requirements:

1. Non-corroding and weatherproof housing with sensor shield suitable for exterior installations.

2. 4-20 mA output proportional to the ambient light level.

3. Mounted on the exterior of a North wall on the roof.

4. Sensor reading from 0 to 750 foot candles.

Q. Occupancy Sensor

1. The ultrasonic occupancy sensors shall be capable of detecting presence in thecontrol area by detecting doppler shifts in transmitted ultrasound.

2. Sensors shall use patent pending ultrasonic diffusion technology that spreads coverage to a wider area.

3. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advance Signal Processing, which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and airflow throughout controlled space.

4. To avoid false ON activation and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.

5. Sensors of varying frequencies shall not be allowed so as to prevent sensors from interfering with each other and to assure compatibility in the event more sensors are added.

6. Sensors shall operate at 24 VDC/VAC and half-wave rectified.

7. Detection shall be maintained when a person of average size and weight moves only within or a maximum distance of twelve inches either in a horizontal or vertical manner at the approximate speed of 12 inches per second. The sum of this distance, volume and speed represent the average condition ultrasonic sensors must meet in order for the lights to not go off when a person is reading or writing while seated at a desk.

8. Sensors shall have a manual on function that is facilitated by installing a momentary switch.

9. Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360° of coverage.

10. Sensors shall utilize SmartSet technology to optimize time delay and sensitivity settings to fit occupants usage patterns. The use of SmartSet shall be selectable with a DIP switch. Sensor shall have user-adjustable sensitivity setting.

11. Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

12. Sensors shall cover 360° and up to 2000 square feet of walking motion.

13. Sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed, and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

14. Sensors shall have a time delay that is adjusted automatically (with the SmartSet setting) or shall have a fixed time delay of 5 to 30 minutes, set by dipswitch.

15. Sensors shall feature terminal style wiring, which makes installation easier.

16. The sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disable for applications that requires less visibility.

17. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

18. Sensor shall have standard five year warranty and shall be UL and CUL listed.

R. Water flowmeter –- insertion type: Provide water flowmeters as indicated in the Field Point Schedules. Turbine flowmeter shall meet, at minimum, the following requirements:

1. Stainless steel insertion probe with non-metallic rotors.

2. 2.0 % accuracy of actual reading from 0.4 to 20 ft/s.

3. Turndown ratio of 30:1.

4. Pulse output proportional to flow rate.

5. Insertion type single turbine on applications with 20 diameters of pipe upstream and 5 diameters of pipe downstream. Insertion type dual turbine flow meters on applications with 10 diameters of pipe upstream and 5 diameters of pipe downstream.

6. Suitable for maximum flow rate in line.

7. Provide valve to allow for removal and re-insertion without disruption to the water service.

8. Provide Onicon or approved equal.

S. Variable Speed Drives

1. General

a. VFD’s shall be provided as required under this section for all pump and air handling unit motors 10 HP and above. All VFD’s for fan coil units and unit ventilators shall be provided, installed and wired by the equipment manufacturer.

2. Acceptable manufacturers of VFD’s are:

a. ABB, Danfoss

3. Ratings:

a. Input 380/415/440/460 VAC +/- 10%, 3 phase, 48-63 Hz or input 200/208/220/230 VAC +/- 10%, 3 phase, 48-63 Hz.

b. Output Frequency 0 to 120 Hz

c. Environmental operating conditions: 0 to 40□C, 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.

d. Enclosure shall be UL Type 1.

e. Starting Torque: 175% starting torque shall be available from .5 Hz to 60 Hz.

f. Must meet RFI requirements as specified by IEC STD EN 61000-2(-) (2001) for variable frequency drives.

4. Design

a. All VFD must be solid state, utilizing Space Vector PWM control for lower motor operating temperature and lower THD on the output. The VFD package as specified herein shall be enclosed in a UL Type 1 enclosure, completely assembled and tested by the manufacturer.

b. All VFD shall include a digital display, and keypad, regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus. The keypad shall be removable, capable of remote mounting, and shall have its own non-volatile memory. The keypad shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD.

c. c. All VFD must have adjustable carrier frequency and up to 4 programmable V/Hz points.

d. All VFD's must have BAS (Building Automation System) BACnet protocol and shall reside on the BACnet MSTP network communicating at speeds up to 76.8 Kbps or the BACnet/ARCNET network, communicating at 156 Kbps.

e. All VFD shall be selectable as in both Volts/Hertz or Sensorless Vector Control mode regardless of horsepower rating.

f. All VFD must have a motor preheat function to prevent moisture accumulation in an idle motor.

g. All VFD shall include two independent analog inputs as standard, 0 – 10VDC and 4-20mA. Both analog inputs shall be utilized as speed references, or as PID inputs. The analog inputs shall be programmed as an individual reference at a time, or as a combined reference together. A second PID loop control shall be provided for control of external equipment.

h. All VFD shall include a minimum of 8 multi-function input terminals, capable of being programmed to a function on a change of state. These terminals shall provide up to 30 functions, including, but not limited to:

(i) External Trip

(ii) Forward

(iii) Reverse

(iv) Three Wire Control

(v) Multi-step Speed Selection

(vi) Interlock

(vii) Jog

(viii) Pre-excite/Motor Preheat

i. The VFD shall provide frequency setting resolution of 0.01 Hz when its Digital Reference is utilized below 100 Hz and 0.1 Hz over 100 Hz. The VFD shall provide frequency setting resolution of 0.03 Hz / 60 Hz when Analog Reference is utilized.

j. The VFD shall have the ability to automatically restart after an overcurrent, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.

k. The VFD shall be capable of both Automatic and Manual Torque Boost function to overcome sudden fluctuation of the load.

l. The VFD shall be equipped with Auto-tuning feature for motor data analysis resulting in optimized motor performance.

m. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to set-point without safety tripping or component damage (flying start). The VFD shall also be capable of DC injection braking at start to stop a reverse spinning motor prior to ramp.

n. The VFD shall be equipped with an automatic extended power loss ridethrough circuit, which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Typical control power loss ride-through for a fan load shall be 2 seconds minimum.

o. All VFD shall have 1 analog output (0-10VDC) which can be programmed to function as one of the following: Output Frequency, Output Current, Output Voltage, DC Link Voltage. Default is set to Output Frequency.

p. If the input reference (4-20mA or 0-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, or (3) hold the VFD speed based on the last good reference received. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

q. The customer terminal strip shall be isolated from the line and ground.

r. The drive shall employ current limit circuits to provide “trip-less” operation

s. The Maximum current limit shall be fixed at 150% (minimum, instantaneous) of the VFD normal duty current rating.

t. The overload rating of the drive shall be 120% of Rated Current for 1 Min., 150% of Rated Current for 0.5 sec.

u. The VFD shall have 8 Step Speeds that are preprogrammed via Digital Input Terminals.

v. The VFD shall have standard Emergency Input and Jog Input Terminals.

w. The VFD shall provide from 0 to 6000 seconds of Acceleration and Deceleration time setting parameters. Up to 8 Acceleration and 8 Deceleration times shall be programmable.

x. The VFD shall be optimized for various levels of carrier frequency programmable from 1 to 15 kHz (1 – 3 kHz above 40HP) to reduce motor noise and to provide high system efficiency.

y. The VFD must have an option to operate multiple motors with single VFD and be able to turn on/off each motors independently as well as simultaneously.

z. The VFD must have an Energy Saving function in auto and manual mode.

aa. The VFD must have Bi-directional "Speed search" capability.

bb. The VFD shall include provisions for multi-motor control as an option or as standard, enabling control of up to 4 motors.

cc. All VFD include the following programming adjustment capabilities:

(i) Directional Lock selection to prevent the unexpected motor direction.

(ii) DC Injection start and stop frequency selection from Minimum output frequency to 60 Hz.

(iii) Three programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

(iv) Pre-magnetization selection for the motor to build up an adequate level of flux for enhanced starting torque or programmable Volts/Hertz points selection for flexible Variable and Constant load demand curve and fluctuation.

(v) VFD Voltage-output to motor adjustment feature enabling the VFD to generate from 40% up to 110% of nominal input voltage to the VFD.

(vi) Five (5) Fault Histories with detailed description of frequency, current, and other operational status at the time of each fault.

(vii) Two independently adjustable acceleration and deceleration ramps. These ramp times shall be adjustable from 1 to 6000 seconds.

(viii) The VFD shall Ramp or Coast to a stop, DC Injection, as selected by the user.

dd. The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop and announce the fault condition.

(i) IGBT overcurrent protection ii. Overcurrent trip on load output

(ii) DC overvoltage

(iii) Internal over temperature

(iv) Ground Fault

(v) Low Voltage

(vi) Open output phase

(vii) Electronic Thermal Protection. The Electronic Thermal Overload protection shall protect the motor based on speed, load curve, and motor parameters.

ee. PC software and for parameter upload/download/graphing shall be provided at no additional charge.

5. Additional Features

a. Three switch Manual Bypass shall be provided on motors 10 HP and up. VFD and bypass components shall be mounted inside a common NEMA 1 enclosure, fully pre-wired, and ready for installation as a single UL listed device. Bypass shall include the following:

(i) Output, and bypass contactors, to switch power from the VFD to bypass.

(ii) UL 508E Manual Motor Starter with pad-lockable handle to isolate the drive and protect the motor while operating in the bypass mode.

(iii) Control and safety circuit terminal strip.

(iv) Drive/Off/Bypass selector switch and Hand/Off/Auto selector switch.

(v) Switch selectable smoke purge, auto transfer to bypass and remote transfer functions.

(vi) Pilot lights (22 mm LEDs) for, “Drive Run” and “Bypass”.

(vii) Hand/Off/Auto selector switch shall provide the following operation:

(1) Hand Position - The drive is given a start command, and the drive will run at preset speed- user adjustable.

(2) Off Position - The start command is removed, all speed inputs are ignored, and power is still applied to the drive. If in bypass mode, the motor is stopped.

(3) Auto Position - The drive is enabled to receive a start command and speed input from a building automation system. If in bypass mode, the motor start/stop is controlled by the building automation system

(viii) Annunciation contacts for drive run, drive fault, bypass run and motor OL/safety fault.

(ix) VFD operator/keypad selection, LCD multi-line display.

b. Enclosure:

(i) NEMA 1 extended enclosure, to house additional equipment within the VFD enclosure for VFDs not requiring Bypass.

(ii) NEMA 12 FVFF (Forced Ventilation inlet Filter and outlet Filter) enclosures with filters and blower.

(iii) NEMA 3R enclosures for outdoor installations.

c. RFI (Radio Frequency Interference) filters to further attenuate possible VFD generated noise shall be provided. Line reactors shall be provided on the input side of the drive for harmonic suppression and input rectifier protection.

d. Surge suppression shall be provided to protect the drive from input power disturbances.

e. Output reactors shall be provided on the output side of the drive for motorprotection in long motor lead length situations when required.

f. Serial communication gateway for BACnet shall be provided via an isolated RS485 circuit board to connect to the BACnet MSTP network at 76.8 Kbps or the BACnet/ARCnet network at 156 Kbps.

g. Speed potentiometer shall be provided in addition to the digital keypad speed command capabilities.

h. Output motor protection (dv/dt) filter shall be provided to accomplish, long motor lead length solutions when required.

i. Engraved cabinet nameplates shall be provided.

6. Installation

a. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

b. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

T. AIR FLOW MONITORING STATIONS

1. Air flow monitoring devices shall be provided under this section for all duct and plenum mounted airflow and temperature measurement and fan inlet mounted airflow measurement.

2. ACCEPTABLE MANUFACTURERS

a. Subject to compliance with performance and design requirements of this Section, provide products that comply with this specification by one of the following vendors:

(i) EBTRON, Inc. Models GTx116-PC (basis of design) and GTx116-F

(ii) Alternatives requesting acceptance as “equals” less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

(1) For any product to be considered for substitution a written section-by-section detailed exceptions/compliance document shall be submitted to the Engineer before any approval will be considered.

(2) Any firm submitting a product as an equal shall make available a functioning non-fan powered demonstration sample for review in the specifying engineer’s office.

(3) Or approved equal.

(4) No honeycomb air flow monitoring stations will be considered.

3. AIRFLOW/TEMPERATURE MEASUREMENT DEVICES

a. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans.

(i) Fan inlet measurement devices shall not be used unless indicated on drawings or schedules.

b. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location.

(i) Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

(ii) Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment. Thermistor leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections.

(iii) The airflow rate at each sensor node shall be equally weighted and arithmetically averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as 'industrialgrade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.

(iv) The temperature at each sensor node shall be arithmetically averaged or velocity weighted and averaged by the transmitter prior to output, either as field-selected by the contractor or user.

(v) Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.

(vi) Other than the thermistor sensors, no other electronic components shall be located at the sensing node.

(vii) Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable.

(viii) Devices with RJ-45 connections exposed to the environment or having electronic circuitry mounted in or at the sensor node are not acceptable.

(ix) Pitot tubes and arrays are not acceptable.

(x) Vortex shedding devices are not acceptable.

c. All Sensor Probes

(i) Each sensor node, consisting of two thermistor-sensors and their structural housing, shall independently determine the airflow rate and temperature at each measurement point.

(ii) Each sensor node shall be factory calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST). Thermistor sensor calibrations traceable only to temperature standards are not acceptable.

(iii) Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range of not less than 0 to 5,000 fpm (25.4 m/s) and not more than 0 to 10,000 fpm (50.8 m/s).

(1) Devices whose overall performance at the host controller input terminals is the combined accuracy of the transmitter and sensor probes shall demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

(iv) Temperature accuracy shall be +/-0.14° F (0.08° C) over the entire operating temperature range of -20° F to 160° F (-28.9° C to 71° C).

(v) The operating humidity range for each sensor probe shall be 0- 99% RH (non-condensing). Product design shall consider direct exposure to or emersion in liquid water and temporary exposure shall not damage the sensing elements.

(vi) Each sensor or probe assembly shall not require matching to the transmitter in the field.

(vii) A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

d. Duct and Plenum Probes

(i) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes or optionally of Type 316 stainless steel tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.

(ii) The number of individual sensor nodes provided for each location shall be as follows:

Duct or Plenum Area (ft2)	Total # Nodes / Location	Duct or Plenum Area (m2)
<= 1	1 or 2	<= 0.093
>1 to <4	4	>0.093 to < 0.372
4to < 8	6	0.372 to < 0.743
8 to < 12	8	0.743 to < 1.115
12 to <16	12	1.115 to < 1.486
>=16	16	>= 1.486

(iii) Sensor probe design shall be capable of providing up to 8 sensor nodes per probe.

(iv) The minimum operating airflow range shall be 0 to 5,000 FPM (25.4 m/s) unless otherwise indicated on the plans.

(v) Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Cables shall include a terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated. PVC jacketed cables or PVC insulated conductors are not acceptable with ducted sensor probes.

e. Fan Inlet Probes

(i) Sensor node assemblies shall be mounted on Type 304 stainless steel housings.

(ii) Mounting rods shall be field adjustable to fit the fan inlet and constructed of zinc plated steel.

(iii) Mounting styles required shall be indicated on the plans as either “face mount” or “throat mount.”

(1) Face mounting style shall provide no mechanical fastening in the throat or on the surface of the inlet cone and shall be used on all inlet condition-sensitive plenum type or plug fans.

(iv) Mounting feet shall be constructed of Type 304 stainless steel.

(v) The minimum operating airflow range shall be 0 to 10,000 FPM (50.8 m/s) unless otherwise indicated on the plans.

(vi) Fan inlet probe cables shall be UL plenum-rated and may be FEP or PVC jacketed.

f. Transmitters

(i) The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor node.

(ii) The transmitter shall be capable of field configuration and diagnostics using an on- board pushbutton interface and LCD display.

(iii) The transmitter shall have an on-off power switch and operate on 24 VAC. Isolation transformers shall not be required.

(1) The transmitter shall use a switching power supply, fused and protected from transients and power surges.

(2) The transmitter shall use “watch-dog” circuitry to assure automatic reset after power disruption, transients and brown-outs.

(iv) All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.

(v) The operating temperature range for the transmitter shall be -20° F to 120° F (-28.9° C to 48.9° C). The transmitter shall be installed at a location that is protected from weather and water.

(vi) The transmitter shall be capable of communicating with other devices using one of the following interface options:

(1) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and electrically isolated from all other circuitry, 0-5VDC / 0-10VDC / 4-20mA (4- wire)

(2) RS-485: Field selectable BACnet-MS/TP, BACnet- ARCNET, Modbus-RTU or Johnson Controls N2-Bus

- BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

(3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP

- Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a MS Windows -based PC.

(4) LonWorks Free Topology

(vii) The transmitter shall be capable of providing an infra-red interface for manually downloading airflow and temperature data or for uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).

(1) Provide PDA upload/download software for multiple users.

- Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.
- Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.

(2) Provide a Microsoft Excel file capable of creating test and balance reports from PDA data files transferred to a Windows based PC.

(3) Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows based PC to a PDA for upload to one or more transmitters.

(viii) The transmitter shall be capable of identifying a 'damaged' sensor node, ignore it and continue to operate by correctly averaging the remaining sensor nodes.

g. The ATMD shall carry the CE Mark for European Union shipments, certifying compliance with all applicable compliance testing, regulations and EU directives.

h. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.

(i) A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

2.13 PANELS

A. Provide panels and enclosures for all components of the CS, which are susceptible to physical or environmental damage.

B. Interior panels and enclosures shall meet be NEMA 1 rated painted steel panels with locking door.

C. Exterior mounted panels and enclosures shall be NEMA 4 painted steel panels with locking door.

D. Panels for UC's shall be mounted outside of all unit ventilators and fan coil units with three feet of wall clearance in front of them and no higher than 7 feet to the bottom of the panel.

2.14 LABELING and WARNING NOTICES

A. Provide labeling for all UC panels and enclosures.

B. Provide labeling of all cables and input/output points at the controller in all wall mounted panels.

C. Provide high voltage warning notices at all equipment controlled by the CS and at all associated motor starters when used by equipment controller.

2.15 TUBING AND PIPING

A. Provide tubing and piping as required for the field instrumentation.

B. Tubing within equipment rooms, vertical risers, and penetrations to ductwork shall be either copper pipe or shall be plastic tubing within conduit. Tubing for all water-based instrumentation shall be copper pipe. Identify the type of tubing proposed in the shop drawing submittal.

C. Provide suitable bulk head fittings for duct and panel penetrations.

D. Tubing in plenum rated areas shall be plastic tubing. Plastic tubing shall meet, at minimum, the following requirements:

1. Flame retardant.

2. Crack resistant.

3. Polyethylene tubing.

4. 300 psi burst pressure.

2.16 CONDUIT AND FITTINGS

A. Provide all conduit, raceways and fittings for the CS monitoring, communication and control cabling. All work shall meet all applicable codes.

B. Conduit, where required, shall meet, the requirements specified within Division 26.

C. Conduit shall be provided whenever one of the following conditions exists:

1. Conduit is required by code.

2. Conduit is indicated on the drawings or specifically required by the specifications.

3. Cabling runs through inaccessible areas such as within partitions/walls, above closed in ceilings, under floor, within trenches on the exterior of the building, when encased in concrete or other material that makes the cable inaccessible or when located such that access to the cable is not readily obtained.

4. Cable within mechanical, telecommunications and electrical equipment rooms and control rooms shall be enclosed within conduit.

5. Cable run on the exterior of the building shall be in conduit.

6. 6. Cable run on an exposed surface shall be in conduit.

7. Conduit shall be installed, inside wall from sensor box to above the wall, for all wall mounted temperature, humidity and CO2 sensors.

D. CS monitoring and control cable shall not share conduit with cable carrying voltages in excess of 48 volts.

2.17 CABLING

A. Provide all cables for the CS. Cable shall meet, at minimum, the following requirements:

1. Minimum 98% conductivity stranded copper.

2. Proper impedance for the application as recommended by the CS component manufacturer.

3. Monitoring and control cable shall be #18 AWG or larger, dependent on the application. Analog input and output cabling shall be shielded.

4. Management Level Network cable shall be CAT 6, 24 gauge unshielded.

5. Automation Level Network cable shall be #24 AWG shielded.

6. Shield shall be grounded at the CCP, UC, or control panel. Ground at one end only to avoid ground loops.

7. Identification of each end at the termination point. Identification should be indicated on and correspond to the record drawings.

B. 120 VAC power wiring shall be of #12 AWG solid conductor or larger as required.

C. All cable within the building shall be plenum rated cable where required by code. All cable that is not enclosed in conduit shall be plenum rated cable. Plenum rated cable not in conduit shall be routed parallel and perpendicular with the building column lines. Cable may follow ductwork routing and may be fixed to the top or side of the ductwork. If cabling does not follow the ductwork routing, it shall be fixed tight to the structure above. Provide cable bridal rings and beam clamps, at minimum, 15 ft. to support the cabling.

D. All cable run underground shall be underground or direct burial rated cable.

PART 3 - EXECUTION

3.1 TRAINING

A. Training: The contractor shall provide 8 hours of initial training to HISD maintenance personnel in a laboratory learning center environment for each project completed. This initial class will be Operator Overview. Thereafter the contractor shall provide training at least for the life of the product to HISD maintenance personnel in a laboratory learning center environment for as long as they are an installing contractor. Training will be done by Factory Certified personnel. Students shall be provided with a dedicated computer workstation utilizing a simulated BAS software platform that is installed for this project. Provide documentation for this requirement in the initial BAS submittal following substantial completion. Training shall include the following: at no cost to the District.

B. Classes 2 through 6 shall be given when requested by HISD. No more than once yearly. They shall lead to Factory Certification if Tech passes the Certification Test.

1. Operator Overview – General system navigation, scheduling functions, setpoint modifications, scheduling and parameter adjustments.

2. Advanced Topics Overview – Procedures for detailed analysis of trend setup/configuration, trend historian, alarm setup, alarm actions (email, printing, etc.), point renaming, and detailed analysis of equipment parameters.

3. Program/Logic Manipulation – Procedures for modifying system programs as needed for additions and modifications.

4. Graphic Manipulation – How to modify system graphics as needed for additions and modifications.

5. Hardware Troubleshooting – Learning center setup shall have HVAC mock-up systems. Operators shall be able to interact with this live system through the BAS utilized for this project. Class will provide students the ability to identify and repair common problems regularly encountered.

6. Software Troubleshooting - Learning center setup shall have HVAC mock-up systems. Operators shall be able to interact with this live system through the BAS utilized for this project. Training will provide students with the ability to identify and repair common issues that are correctable by means of software modifications.

7. Central Plant Operation – At a minimum the instructor shall thoroughly explain different types of central plant equipment and appropriate BAS system modifications that can be made to enhance system performance and energy savings.

3.2 INSPECTION DURING INSTALLATION

A. Prior to acceptance testing, the CS shall be available for use by the Owner. Use by the Owner shall not imply acceptance of any component of the CS or the commencement of the warranty period.

B. Provide staff to assist the Owner/Engineer with inspections made during the installation period that are required to review the progress and quality of ongoing work. The Owner/Engineer will generate Field Observation Reports on the findings of the inspection. The Owner/Engineer shall advise the CS Contractor during the inspection of any concerns noted with respect to the installation and shall repeat the concerns in writing as soon as possible after the inspection is completed. The CS Contractor shall take corrective action to meet the requirements of the specifications.

3.3 COMMISSIONING REQUIREMENTS

A. Control system shall be set up and checked by factory trained competent technicians skilled in the setting up and adjustment of the BAS equipment used in this project. This technician is to be experienced in the type of HVAC systems associated with this project.

B. After completion of the commissioning, this contractor will demonstrate the sequence of operations for each system to the mechanical engineer or his representative.

C. Equipment checkout sheets are to be used by the CS contractor. They shall include a point to point check for each piece of equipment and turned over to the owner and/or mechanical engineer. It shall be signed & dated by CS contractor.

D. Check all equipment to see that it follows the sequence of operation.

E. OUTSIDE AHU/ERV

1. Check all wiring from controller to each end device including any starters, VFDs, and dampers.

2. Check the controllers for shorts, correct power and change 4-20 jumpers.

3. Check that the communication jumpers are set properly.

4. If any safety devices are present, check that they are wired properly. If they are adjustable make sure that they are set to the proper setting before operating any equipment.

5. Stroke dampers and valves for proper operation.

6. Set dampers and valves up in the software. Once the damper actuators are set up they are to be marked.

7. Check and calibrate all temperature sensors. If humidity is present check that it is set up properly in the software.

8. Start / Stop the unit to check starter or VFD for proper operation. While unit is running check status input.

9. Check start / stop of any ex-fans associated with the unit.

F. SINGLE ZONE AHU/FCU

1. Check all wiring from module can(s) to each end device including any starters, VFDs, and dampers.
2. Check the module(s) for shorts, correct power and change 4-20 jumpers.
3. Check that the communication jumpers are set properly.
4. Install the correct fuses and begin memory download.
5. If any safety devices are present check that they are wired properly. If they are adjustable make .sure that they are set to the proper setting before operating any equipment.
6. Stroke dampers and valves for proper operation. Set dampers and valves up in the software.
7. Check and calibrate all temperature sensors. If humidity is present check that it is set up properly in the software.
8. Start / Stop the unit to check starter or VFD for proper operation. While unit is running check for unit status.
9. Check start / stop of any ex-fans associated with the unit.
10. Check all equipment to see that it follows the sequence of operation.

G. VAV AHU

1. Check all wiring from module can(s) to each end device including any starters, VFDs, and dampers.
2. Check the module(s) for shorts, correct power and change 4-20 jumpers.
3. Check that the communication jumpers are set properly.
4. If any safety devices are present check that they are wired properly. If they are adjustable make sure that they are set to the proper setting before operating any equipment.
5. Stroke dampers and valves for proper operation. Set dampers and valves up in the software.
6. Check and calibrate all temperature sensors. If humidity is present check that it is set up properly in the software.
7. Verify that the VFDs have been set up by the drive start up personal.
8. Check VAV boxes and make sure that all dampers are open before you start / stop the AHU.
9. This will keep the ductwork for being damaged.
10. Start / Stop the unit to check starter or VFD for proper operation. While unit is running check for status.
11. Check start / stop of any ex-fans associated with the unit.
12. Check all equipment to see that it follows the sequence of operation.

H. TERMINAL UNITS

1. Check physical location of box and sensor.

2. Verify the access to the control cabinet, any obstructions in the ductwork, and the proper tygon tubing has been used and that it is supported properly.

3. Verify proper address of card, check all wiring with schematic, and box manufacturer wiring schematic. (Proper transformer installed from manufacturer)

4. Check tubing on airflow cross, verify the high side is connected to the high side and the low side is connected to the low side and, also that caps are installed on the pneumatic tees if installed in the flow cross tubing. The high side is the side of the air flow cross sensor that is facing the inlet or air handler side of the ductwork.

5. Verify stroke of damper (Clockwise/counterclockwise to close). Check tightness of actuator linkage to shaft. Make sure damper is left in open position.

6. Verify heat strips energize and time of stages is accurate.

7. Verify correct flow loop #, configuration, CFMs, damper motor run time, hot water valve run time, etc.

8. Verify correct damper direction for open and close, input/output addresses and global modify changes.

9. Under the flow control, zero the terminal unit by inputting the current raw sensor reading into raw sensor reading for zero flow. ALL FANS MUST BE OFF.

10. Turn air handler on and verify airflow reading at each terminal unit.

3.4 CONTROL SYSTEM DEMONSTRATION and ACCEPTANCE

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 4.3 (Commissioning Requirements). Provide Engineer with log documenting completion of startup tests.

1. Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.

2. Demonstration shall follow process submitted and approved under Section 23 09 00 Article 1.11 (Shop Drawings). Complete approved checklists and forms for each system as part of system demonstration.

3. Demonstrate actual field operation of each sequence of operation as specified in Sequence of Operations. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.

4. Demonstrate compliance with sequences of operation through each operational mode.

5. Demonstrate complete operation of operator interface.

6. Demonstrate each of the following.

a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on

loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.

b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demandlimiting setpoint, and status of setpoints and other affected equipment parameters.

c. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 23 09 00. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 23 09 00 Article 2.9 Paragraph E. (Dynamic Graphical Trending).

7. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

8. Prepare a log documenting startup testing of each input and output device, with technician's initials and date certifying each device has been tested and calibrated. This document shall indicate proof that the following functions have been commissioned. Include this information in the as built document

   a. Short to ground check.

   b. Trend configuration

   c. Graphic display

   d. Point to point

   e. Lock point on. Equipment reaction.

   f. Unlock point. Equipment reaction.

   g. Equipment location correct

   h. Signal type

   i. Stroke control valve

   j. Verify damper actuator operation

   k. Module address verification

   l. VAV box crossflow caps verified

   m. Verify interlocks and shutdowns

9. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 09 00.

10. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.

11. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.

12. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.

13. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.

14. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.

15. Alarms and Interlocks.

    a. Check each alarm with an appropriate signal at a value that will trip the alarm.

    b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.

    c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

B. Acceptance.

1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 00 Article 1.11 (Shop Drawings).

3.5 HANGING AND SUPPORTING

A. Install all equipment, devices, materials and components in compliance with the manufacturer’s recommendations. Supports shall be suitable for the environment within which the component is to be installed. Coordinate all hanging and supporting of components with all trades.

B. Provide sleeves for all cable and conduit passing through walls, partitions, structural components, floors and roof

3.6 HARDWIRED INTERLOCKS

A. Provide all required hardwired interlocks between fans, intake and discharge dampers, and motor actuated damper as identified within this specification or the Mechanical Drawings, whether or not furnished under this Section unless the fan is furnished with interlock by fan manufacturer.

3.7 SEQUENCES OF OPERATION SOFTWARE

A. Refer to Control Diagrams for Sequences of Operation.

3.8 CS POINT SCHEDULES

A. Refer to the control diagrams for points lists.

B. The column headed POINT provides an English language description of the point to bemonitored or controlled.

C. The column headed BI indicates digital input monitoring.

D. The column headed BO indicate digital output control.

E. The column headed AI indicates analog input monitoring.

F. The column headed AO indicates analog output control.

G. The column headed HI indicates hardwired interface.

H. The column headed CI indicates digital communications interface to a third party monitoring or controlling device.

END OF SECTION 23 09 23

SECTION 23 09 93
SEQUENCE OF OPERATION

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. General Sequence issues.

B. Systems are as detailed on the control diagram drawings.

1.3 RELATED SECTIONS

A. Section 23 0923 - Direct Digital Control Systems.

B. Section 23 0963 – Space Pressurization Tracking Systems.

1.4 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 3300 and 01 3400.

B. Submit diagrams indicating mechanical system controlled and control system components. Label with settings, adjustable range of control and limits. Include written description of control sequence.

C. Include flow diagrams for each control system, graphically depicting control logic.

D. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.6 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 01 7700 and 01 7839.

B. Accurately record actual setpoints and settings of controls, including changes to sequences made after submission of shop drawings.

PART 2 SEQUENCES

2.1 BCAS SEQUENCE OF OPERATION RELATED REQUIREMENTS

A. Reporting requirements: Provide the following custom BCAS reports.

1. AHU VFD percent of full load per AHU
2. Pump VFD percent of full load per pump.
3. Exhaust Fan VFD percent of full load per fan.
4. Building Electrical demand
5. Building Chilled Water Demand (BTU)
6. Outside air temperature with dew point and CO2 readings.
7. Equipment run time summaries
8. Alarm reports for all alarms
9. Dilution Damper Positions % of open per damper.
10. All other trend logs, alarm logs and data logs listed or described within the following sequences.

B. Operator Workstations with Full Schedule and Graphics Capability:

1. The following work station computers and accessories shall have the capacity, software to store as backup, display and actively report requested data as indicated or required by this sequence of operations and comply with the requirements of the equipment section of the controls specifications. Final equipment locations shall be as directed by the Owner.

ID	Type	Location	Function	Notes
OWS1	Desktop PC	Engineering Office	HVAC	Microsoft latest version (or that agreed upon by HISD)
OWS2	Laptop PC	N/A	HVAC	Full desktop functionality required - Microsoft latest version (or that agreed upon by HISD)
Printer 1	HP LaserJet	Engineering Office	HVAC	BCAS compatible

C. Software Integration:

1. Integrate all new graphics and points, the Owner's Work Station (OWS) and the existing network map to allow monitoring of any campus building now connected through the campus Ethernet system. Map the existing campus network for a seamless integration of the new system into the existing campus network.

D. Graphic Displays for the High School:

1. Provide an active data color graphic system with flow diagram display for each system with all displayed points as indicated in the sequence or in the sequence point list. Provide Historical Data Viewer capability.

2. For this building, provide a color graphic display of the building elevation, each floor plan and each system described herein. Indicate each HVAC zone or control area with active data display, color coded to indicate zone values and status. Allow selection of specific areas, systems and equipment of concern through standard point and click technology. Provide Historical Data Viewer functionality.

3. User shall access the various system schematics and floor plans via a graphical penetration scheme and/or menu selection.

    a. User shall penetrate from building elevation to floor plan to associated HVAC system to equipment graphic and to more specific components.

4. Format and configuration of all graphics shall be approved by the Owner's Representative. Sample graphics of each type used shall be submitted for approval prior to implementation.

E. Generic System Control Sequence Requirements which May Not Be Repeated in the Sequence, but shall be provided:

1. General

    a. All damper and valve actuation shall be electric:

    b. Damper over 10 square feet in area shall have two actuators that shall be operated in sequence.

    c. All devices shall be current technology.

    d. All products or components needed to provide a complete sequence as described herein shall be provided whether specifically mentioned or not.

    e. These specifications are generic where possible, and describe, in general, only the basic sequence requirements and sequence details. This supplier shall furnish all manufacturer specific components required for a full operational systems and sequence.

    f. Unless specifically noted, all motors shall be started and stopped (enabled and disabled) and otherwise controlled through the automation system and shall be associated with a schedule of operation unless operated continuously or provided with an equipment or system specific integral control system (fire pumps, house pumps etc).

2. Primary Equipment:

    a. All major control components as specified herein shall be manufactured or supplied by the Control Company and all warrantees shall be by that company. Pass through warrantees are not acceptable.

F. Overviews of the Systems for Which Detailed Sequences are Required. The following are minimum requirements for which system specific detailed controls may follow

1. HVAC Pumping Equipment:

    a. All pumps shall be started and stopped (enabled/disabled) via the DDC controls.

    b. All pump speeds shall be controlled via the DDC controls where speed control is specified.

c. All pumps shall be controlled with DDC controllers which will continue to function during a communication loss (standalone capable).

d. All valve actuation shall be electric except as noted above.

e. All units shall be monitored through:

(i) Discharge temperature sensors.

(ii) Individual discharge or Delta Pressure (DP) sensor

(iii) Individual Pump VFD loading data direct from the VFD

2. Exhaust Fans:

a. All exhaust fans shall be started and stopped (enabled/disabled) via the DDC controls.

b. All exhaust fans speeds shall be controlled via the DDC controls through the associated VFD where specified.

c. All exhaust fan systems shall be monitored and controlled with DDC controllers which will continue to function during a communication loss (standalone capable).

d. All damper and valve actuation shall be electric except as noted above.

e. All units shall be monitored through:

(i) Suction or manifold pressure.

(ii) Individual Fan Delta Pressure (DP) sensor

(iii) Individual Fan VFD loading data direct from the VFD

3. Air Handling Equipment:

a. All air handlers shall be started and stopped (enabled/disabled) via the DDC controls.

b. All air handlers (fan) speeds shall be controlled via the DDC controls through the associated VFD.

c. All air handlers shall be monitored and controlled with DDC controllers which will continue to function during a communication loss (standalone capable).

d. All damper and valve actuation shall be electric except as noted above.

e. All units shall be monitored through:

(i) Intake or outside air temperature dew point sensors.

(ii) Discharge pressure, temperature and dew point sensors.

(iii) Individual filter Delta Pressure (DP) sensor

(iv) Individual Fan Delta Pressure (DP) sensor

(v) Individual Fan VFD loading data direct from the VFD

4. Cooling coils:

   a. See pump controls.

   b. See AHU Control sequences.

   c. Local cooling coils not located in the AHU, shall have electronic control valves that shall modulate in response to local temperature set points.

5. Fan Coils

   a. Systems include, but are not limited to, mechanical and elevator machine rooms.

   b. Cooling control valves.

   c. Space temperature sensor.

   d. All units shall be monitored through:

      (i) System operation on/off sensor

6. Fire Alarm Interface

   a. All air supply, return, exhaust and transfer systems shall be started and stopped through the Building Control and Automation System.

   b. The fireman’s override panel shall have the capability of monitoring all smoke and fire/smoke damper operations.

   c. All units shall be monitored through:

      (i) Stairwell pressure sensors.

      (ii) System smoke thermal detectors on noted units.

7. Plumbing Pumping Equipment:

   a. All pumps shall be (enabled/disabled) via the DDC controls and started/stopped via integral equipment provided control systems.

   b. All units shall be monitored through:

      (i) Discharge temperature sensors.

      (ii) System discharge or Delta Pressure (DP) sensor

8. Sump Pumps

   a. All units shall be monitored through:

      (i) High level alarm.

(ii) System operation on/off sensor

2.2 DEVICE FAILURE CONTROL SEQUENCES

A. General: Control Sequences for Mechanical/Electrical control devices and controlled equipment shall be electrically and/or mechanically designed such that all of the systems mentioned herein and hereafter, shall operate, fail, restart (as the case may be) to satisfy the following conditions:

1. Chilled water valves and electric heaters shall sequence to protect pipe and coils from freezing temperatures. Freeze protection sensors shall energize electric heating coils and cold water valves in sequence and initiate an alarm to prevent a freeze condition. Air handling units shall not be shut down. Freeze protection sensors shall be a point monitored by the BCAS.

2. Chilled Water control valves are typically selected to fail open upon loss of power.

3. Redundant exhaust fans, supply fans, pumps, motors, etc shall be controlled via the BCAS to start or ramp up to maintain the established set point immediately (less than 5 seconds) upon failure of primary unit(s).

4. Travel time from open to close, or close to open position of isolation dampers(s) at the fans in Exhaust Systems shall be 2 to 5 seconds, maximum. The lab ventilation control systems as specified in Section 23 0963 shall be Phoenix integrated with the selected controls.

5. Lead/Lag or primary secondary operation of Pumps, Supply Fans, Exhaust Fans, shall be a control function of the Equipment DDC controller. Software algorithms such as PPCL (Powers Process Control Language), FPCL (Free Programming control language) or Block Programming is not allowed.

6. All interlocks associated with equipment safety such as heaters, low/high temperature switches, freezstats, high/low pressure switches, proximity and limit switches, vibration switches, differential switches, smoke detectors, control valves, dampers, damper motors, relays, shall be electrically hardwired. Unless otherwise approved by HISD any software generated commands from a DDC controller, PLC, multiplexer, host computer CPU, to be used for equipment safety interlocks is not allowed.

7. On startup with normal or emergency power the VFD ramps for supply and exhaust fans shall be parallel to maintain relative room pressures as the lab controls achieve their controllable differential pressure. Startup ramps are used to minimize inrush and allow all critical fans to initiate the start sequence at one time.

2.3 SEQUENCES OF OPERATION

A. Refer to the control diagrams for sequences of operation and control points to be monitored.

2.4 AUTOMATIC DAMPERS:

A. Automatic dampers (electronic operators), where shown on the Drawings and indicated in the control sequences, shall be interlocked with their related fans. Dampers shall open when the fan is cycled ON, and close when the fan cycled OFF. Return air damper on fan inlets shall open when their respective fans stop. Dampers used for smoke or refrigerant relief shall be fail-safe to open, and be controlled by local smoke detectors, or the Building Alarm System to open on alarm.

2.5 FIRE DAMPERS:

A. General: Fire dampers are provided by Division 23 and are of the spring closed, thermal link activated shutter type and shall not be monitored or controlled by the BCAS.

2.6 FIRE/SMOKE DAMPERS:

A. General: Fire/smoke dampers are provided by Division 23 and are of the normally closed, electrically opened, parallel blade type with fused link type thermal operator.

B. Electric Damper Operation: Dampers shall be powered by the 120 volt power source shown on the electrical drawings via a normally closed fire alarm control relay.

C. Pneumatic Damper Operation: Pneumatic operation of dampers shall be as specified under the Sequence of Operation for the system or equipment serving the ductwork where the damper is located.

2.7 SAFETY CONTROLS:

A. For each supply fan and exhaust fan handling over 2,000 CFM, or additionally required by code, a smoke detector shall be located in the air stream. When the air temperature exceeds 125 degrees F, the unit fan motor shall be de-energized.

B. Where ionization smoke detectors are provided under Division 26, the high temperature thermostats may be omitted.

2.8 PROGRAM CONTROL:

A. General: Each system in the building shall be operated by the local DDC control system and be monitored and adjusted through central BCAS under program control either on a time program or interlocked operation basis.

2.9 SEQUENTIAL START-UP/SHUTDOWN:

A. General: Sequential start-up and shutdown subroutines shall be included in the DDC Control software. These subroutines shall prompt the operator for proper sequential start-up and shutdown of the project. The software shall prompt each controlled piece of equipment or system in a logical sequence to start or shutdown the building. The prompt shall include the current status of the equipment or system and a direction for the operator on the key(s) to enter to start or stop the equipment or system and move on through the sequence. The subroutine shall include options to abort the sequence or to not start or stop specific equipment or systems.

B. Sequential Start-up: Fans, pumps and equipment controlled by the DDC Controls and the BCAS, both automatically and manually, shall be sequentially started to reduce the motor starting load presented to the building power system. The time delay between motor start-up shall be 10 seconds (programmable) for full voltage motor starting and 30 seconds (programmable) for reduced voltage starting. All motor starting including building restarts after power failures shall be sequential.

2.10 EMERGENCY POWER OPERATION:

A. General: Selected portions of the building HVAC system associated with the building life safety system shall be fully operational when the building is operating under emergency power.

B. Stairwell Pressurization Systems: The building stairwell pressurization fans are supplied from the building emergency power system. These fans and related controls shall be fully operational when the building is operating on emergency power.

C. Sequential Start-up: Fans and equipment supplied from the building emergency power system shall be sequentially started to reduce the motor starting load presented to the emergency power system. The time delay between motor start-up shall be 10 seconds (programmable) for full voltage motor starting and 30 seconds (programmable) for reduced voltage motor starting.

2.11 MISCELLANEOUS MONITORING AND ALARMS:

A. General: Provide monitoring of miscellaneous alarms and controls as listed in the input/output summary. Coordinate requirements for connection and alarm interface with the Contractor furnishing and installing the monitored or controlled equipment.

B. Alarms list shall be provided to the owner at the time of submittal for approval.

C. Monitored points shall include:

1. Common alarms on each lab air compressor and vacuum pump.

2. Common alarm for each Sump Pump System Alarm.

3. Generator common alarm.

4. Fire pump common alarm.

5. Domestic water pump common alarm

6. Lighting System Points.

7. Five additional points to be identified.

PART 3-EXECUTION

3.2 INSTALLATION:

A. General: Installation shall be in accordance with applicable Division 23 specification sections.

3.3 SAFETIES ON FANS AND AHU'S

A. Safety Devices:

1. Freeze Protection: Shut the outside air unit down and sound an alarm if temperature before supply fan is below 37 degrees F (3 degrees C). Recirculating units shall remain in operation.

2. High Temperature Protection: Signal an alarm if temperature in return air is above 300 degrees F (150 degrees C); stop fans.

3. Smoke Detector: Stop fans not associated with the lab spaces and close discharge smoke dampers if smoke is detected; signal alarm.

B. Outside Air Damper: When supply fan is "on", open outside air damper. Prevent supply fan starting until outside air damper is open and position is verified.

C. Display:

1. System graphic.
2. System on/off indication.
3. System day/night mode indication.
4. System fan on/off indication
5. Exhaust fan on/off indication.
6. Outside air temperature indication.
7. Fan discharge air temperature indication.
8. Reheat zone air temperature indication.
9. Exhaust air humidity indication.
10. Fan discharge temperature control point adjustment.
11. Supply dew point or humidity control point adjustment.
12. Reheat zone control point adjustment.
13. Supply static pressure indication.
14. Supply static pressure control point adjustment.
15. Building static pressure indication.
16. Building static pressure control point adjustment.
17. System on/off auto switch.
18. Supply fan on/off switch.
19. Preheat coil pump on/off switch.

End of Section 23 0993

SECTION 23 21 00
PIPING, VALVES AND FITTINGS

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Pipe and Pipe Fittings

B. Valves

1.3 RELATED SECTIONS

A. Section - Access Doors and Frames

B. Section - Painting

C. Section 23 0548 - Vibration Isolation

D. Section 23 0719 - Piping Insulation

E. Section 22 1317 - Plumbing Specialties

F. Section 22 4000- Plumbing Fixtures

1.4 REFERENCES

A. AGA - American Gas Association

B. ANSI B31.1 - Power Piping

C. ANSI B31.2 - Fuel Gas Piping

D. ANSI B31.9 - Building Service Piping

E. ASME - Boiler and Pressure Vessel Code

F. ASME Sec. 9 - Welding and Brazing Qualifications

G. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800

H. ASME B16.3 - Malleable Iron Threaded Fittings

I. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250

J. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings

K. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings

L. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV

M. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes

N. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV

O. ASME B16.32 - Cast Copper Alloy Solder-Joint Fittings for Sovent Drainage Systems

P. ASTM A536 Ductile Iron Castings

Q. ASTM A47 - Ferric Malleable Iron Castings

R. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless

S. ASTM A74 - Cast Iron Soil Pipe and Fittings

T. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

U. ASTM B32 - Solder Metal

V. ASTM B42 - Seamless Copper Pipe

W. ASTM B75 - Seamless Copper Tube

X. ASTM B88 - Seamless Copper Water Tube

Y. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube

Z. ASTM B302 - Threadless Copper Pipe (TP)

AA. ASTM B306 - Copper Drainage Tube (DWV)

BB. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe

CC. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings

DD. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

EE. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings

FF. AWS A5.8 - Brazing Filler Metal. BA. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

GG. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids

HH. AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings

II. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

JJ. AWWA C651 - Disinfecting Water Mains

KK. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems

LL. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems

MM. CAN-3 B281 - Aluminum Drain, Waste, and Vent Pipe and Components

NN. NCPWB - Procedure Specifications for Pipe Welding

OO. NFPA 54 - National Fuel Gas Code

PP. NFPA 58 - Storage and Handling of Liquefied Petroleum Gases

QQ. TDH - Texas Department of Health, Water System Regulations

1.5 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 0000.

B. Record actual locations of valves, etc. and prepare valve charts.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 0000.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

C. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

D. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

E. Welder's Certification: In accordance with ASME Sec. 9**.** Submit welder's certifications prior to any shop or field fabrication. Welder's certifications shall be current within six months of submission.

F. Maintain one copy of each document on site.

G. All piping shall be of domestic manufacture.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' documented experience.

B. Installer: Company specializing in performing the work of this section with minimum of three years' documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 0000.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.12 EXTRA MATERIALS

A. Furnish under provisions of Section 23 0000.

B. Provide two repacking kits for each size valve.

PART 2 PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers

1. Globe Valves: Crane/Mueller/Lunkenheimer/Watts/Nibco/Kitz
2. Ball Valves: Apollo/NibcoWatts/Kitz
3. Butterfly Valves: Conbraco/Nibco/Watts/Xomox/Kitz
4. Plug Valves: Dezurik/Xomox/kitz
5. Check Valves: Apollo/Crane/Lunkenheimer/Nibco/Val-Matic/Watts/Kitz
6. Grooved Mechanical Pipe Fittings: Victaulic

B. General Piping Requirements

1. 2” and smaller shall be NPT screwed
2. 2-1/2” and larger may shall be welded or fitted by Victaulic couplings.
3. All piping shall be schedule 40 black steel
4. Chilled water valves shall have extended stem
5. Butterfly valves shall be lug type
6. Chilled water valves shall have extended stem
7. All balancing valves shall have locking indicator handles unless self-regulating cartridge type
8. Balancing valves shall be self regulating, maintaining near constant flow over a wide pressure range. The hydronic system will be self balancing. If a flow needs to be changed, the cartridge of the unit will be changed.
9. Provide blanked off taps at central plant to allow for connection of portable chiller.
10. Avoid routing piping on roof as much as possible.

2.2 STEEL PIPING:

A. Scope: This section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water and fire protection systems.

B. Pipe: Unless otherwise indicated building piping shall be Schedule 40 at 10” and less and Standard weight for 12” and larger, Grade A or B, ERW domestically manufactured black steel pipe conforming in all details to Standard ASTM Designation A135, A106, and A53, latest revisions.

C. Fittings:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weld Bend, Tube Turn, Hackney, or Ladish Company. Attach to only pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed, or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting is to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All grooved end fittings shall be domestic made ductile iron conforming to ASTM A536; wrought steel conforming to ASTM A234; or factory-fabricated from steel pipe conforming to ASTM A53. Grooved ends shall conform with AWWA C606. Adjoining couplings shall consist of two ductile iron housing segments, pressure-responsive gasket, and zinc-electroplated steel bolts and nuts.

   a. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9

      (i) 2” through 8”: Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to +250 deg F / 120 deg C. Victaulic Style 107.

      (ii) Victaulic Zero-Flex Style 07.

b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Installation-Ready Style 177 or Style 77.

c. 14" through 24": Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.

(i) Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.

(ii) Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77.

d. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 / W741.

3. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company or Walworth Company manufacture (300 lb. for unions).

4. All taps off of all mechanical and plumbing water piping shall be minimum of ¾". All taps 2" and smaller shall be with stainless steel nipplpes.

D. FABRICATION:

1. Standard B31.9 –Building Services Piping may be used within buildings. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

9. Procedure of Assembling Grooved Joint Fittings: Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

E. WELD TESTING:

1. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The owner will, at the owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and re-testing of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1, B31.9, and B31.3 due to the discovery of poor, unacceptable, or rejected welds.

2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

3. For each failed weld, the contractor shall be required to perform and pay for five additional tests as selected by the owner.

2.3 CAST IRON PIPING:

A. PIPE & FITTINGS:

1. Service weight cast iron soil pipe conforming to ASTM Specification A-74 and CISPI Standard 301, hub and spigot for pipe ten inch (10") and larger and hubless for eight inch (8") and smaller. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer's mark or name cast on it.

2. All joints in hub and spigot cast iron pipe shall be made water and gas tight with Tyseal neoprene gaskets. Lead and Oakum may be used only under special conditions, with prior written permission from the Resident Construction Manager. Joints in hubless cast iron soil pipe and fittings shall be made by the use of a neoprene sleeve and 24-gauge, Type 304 Stainless Steel shield made tight with a torque wrench and torqued to a minimum of 100 inch-pounds. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material. Each clamp shall bear the FM and UPC stamp, shall be approved to Class I of Factory Mutual Standard #1680, and shall be Clamp-All or approved equal. All elbows and tees shall be braced against thrust loads which might result in joint separation due to static pressure or dynamic forces caused by sudden, heavy impulse loading (water hammer) conditions. Hubless piping systems shall not be used in a directly buried, underground application.

2.4 DUCTILE IRON PIPING

A. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 DUCTILE iron pipe arranged with bell and spigot mechanical joints and shall conform in every detail to Federal Specifications WW-P-421, E-4, Type II for CAST IRON PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS. Grooved joint pipe shall be Class 53 (min) with grooved ends conforming to AWWA C606. This pipe shall be provided in laying lengths of sixteen feet (16'). Each length of pipe shall be plainly marked in such a fashion as to indicate the name or trademark of the manufacturer and the year in which the pipe was

cast. Exterior surfaces shall be completely coated with coal tar pitch varnish to which sufficient oil has been added to effect a smooth coating, tough and tenacious when cold, not "tacky" and not brittle.

B. Fittings:

1. All fittings used for underground water piping mains shall be Class D bell and spigot mechanical joint fittings made in strict conformity with the Specifications of the American Water Works Association A.W.W.A.-C100-08. All dimensions and weights of such fittings shall conform to the dimensions and weights shown in tables included in the latest edition HANDBOOK OF CAST IRON PIPE published by Cast Iron Pipe Research Association. All fittings shall be coated outside with the same coal tar pitch varnish used on cast iron pipe.

2. All mechanical joints shall be for cast iron pressure pipe made by pit cast or by centrifugal methods and cast iron pressure fittings. Mechanical joints shall be of the stuffing box type and shall consist of a bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting; a pipe or fitting spigot; a sealing gasket; a separate cast iron follower gland having cored or drilled bolt holes. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe line.

3. Bolts shall be high strength, heat treated cast iron tee-head bolts with hexagon nuts.

4. Gaskets shall be made of a vulcanized crude rubber compound and, unless otherwise specified, the rubber shall be first grade plantation rubber. The joint, gaskets, bolts, and nuts shall meet the latest requirements of ANSI 21.11 for Mechanical Joints for Cast Pressure Pipe and Fittings.

5. All underground cast iron or ductile iron pipe shall be encased in black 8-mil thick, polyethylene plastic sheet, per ANSI/AWWA, C105/A21.5-82, Method C.

6. Tie rods and retaining bolts shall be all stainless steel construction.

7. All grooved end fittings shall be ductile iron conforming to ASTM A536, Center-to-end dimensions shall conform with ANSI A21.10/AWWA C110, and wall thickness shall conform with ANSI A21.10/AWWA C110 or AWWA C153. Couplings shall consist of two ductile iron housing segments, FlushSeal® gasket, and zinc electroplated steel bolts and nuts. Victaulic Style 31.

   a. For direct connection to IPS steel pipe sizes, Victaulic Style 307 transition coupling may be used. The coupling housings shall be cast with offsetting angle-pattern bolt pads to provide joint rigidity

C. Valves: All valves used in underground water piping systems shall be A.W.W.A., iron body, mechanical joint, double hump, double disc, parallel seats, brass trimmed non-rising stem gate valves.

2.5 COPPER PIPE

A. Copper Pipe: Piping four inches (4") and smaller shall be fabricated of Type K, hard drawn, copper pipe made of deoxidized copper (99.9% pure). This Type K copper pipe shall conform in every detail to ASTM Standard Specifications for COPPER WATER TUBE, Serial Designation B-88-66, and it shall be provided in 20-foot straight lengths. Copper pipe 4” and smaller may only be joined using non-lead-bearing solder, such as 95-5 silver or antimony solder (95 percent tin, and 5 percent silver or antimony). Copper pipe larger than 4” may be joined using copper-tube dimensioned roll grooved fittings and installation-ready couplings.

B. Fittings: All fittings for four inch (4") and smaller water lines shall be Streamline Solder Fittings manufactured by Streamline Pipe and Fittings Division, Mueller Brass Company, or approved equal. These wrought copper fittings shall be rigid and strong with openings machined to accurate capillary fit for the pipe.

C. Grooved End Fittings: All grooved end fittings shall be ANSI B16.18 cast bronze or ANSI B16.22 wrought copper, with copper-tube dimensioned grooved ends. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) Couplings shall consist of two ductile iron housing segments cast with offsetting angle-pattern bolt pads, pressure responsive grade EHP gasket, and zinc-electroplated steel bolts and nuts. Couplings shall be installation-ready, for direct stab installation without field disassembly. Victaulic Style 607.

D. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

2.6 VALVES:

A. All equipment shall have isolation valves and be provided with unions, grooved or flanged connections for maintenance or repair.

B. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. All valves must be of threaded, grooved end or flanged type. No solder connected or grooved fitting valves shall be used on this project. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.

C. All valves used in circulating systems, plumbing shall be Class 150 SWP. Class 300 valves shall be constructed of all ASTM B-61 or B584 composition. All gate, globe and angle valves shall be union bonnet design. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. Alloys used in all bronze ball, gate, globe, check, or angle valves shall contain no more than 15% zinc. No yellow brass valves will be allowed.

D. All iron body valves shall have the pressure containing parts constructed of ASTM designated of grade 65-45-12 ductile iron or A126 class B iron. Stem material shall meet ASTM A582 or A564 stainless steel, B16 Alloy 360 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing.

E. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16-34-1977. Stems shall meet ASTM designation A-186-F6 chromium stainless steel. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6 chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be A-216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

F. All forged steel body valves shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

G. All valves shall be repackable, under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron

hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

H. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.

I. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass valve assembly.

J. Check Valves for Water Systems: Bronze body, 2" and smaller, bronze body regrinding disc and seat with screw-in cap. Iron body, 2 1/2" and larger, coated ductile iron, aluminum-bronze, or bronze disc and seat or non slam grooved end or wafer type with stainless pins and springs, and bronze plate. Forged steel lift check valves, 2" and smaller shall be bolted cap and body, screwed end connections and conform to ANSI B16.34 and pressure temperature rating.

K. Gate valves 2 1/2” and larger shall have approved rating of 175 psi WWP or greater, iron body with resilient rubber encapsulated wedge, epoxy-coated interior, and pre-grooved stem for supervisory switch. Valves 2” and smaller shall be three-piece full port ball valve with stainless steel ball equal to Nibco T-595-66.

L. Balancing Koil-Kit™ Components: To minimize the number of joints and reduce space requirements, install union port fitting and strainer/ball valve combination at coil outlet to complete terminal hookup with stainless steel braided hoses by Victaulic/TA or approved equal.

M. Standards of Quality for Valves:

			Class	Milwaukee	Nibco	Stockham or as noted
*2" & smaller	Ball Valve for shut-off	Domestic Cold Water Plumbing Re-circulating Chilled Water	150	--	T-585-66	Apollo 77-100

Requires extended stems in insulated lines with adjustable memory stop.

2" & smaller	Globe, Angle & Balancing	Chilled Water	150	590T	T-235 Victaulic/TA Style	B-22 786/787
2-1/2" & larger	Globe, Angle & Balancing	Plumbing, & Chilled Water	125	F-2981	F-718-B Victaulic/TA Style	G-514-T 788/789
2-1/2" & larger	Butterfly Valve for Shutoff	Domestic Cold Water Plumbing Systems Re-circulating Chilled Water	150	NE-C,NF	LD2000 Victaulic MasterSeal™ AGS-Vic300 & Series 608	DeZurik 632,L,D, RS66,6

Valves 8” and larger, and valves used for balancing service regardless of size, shall have heavy-duty weatherproof encased gear operator.

2" &	Check Valve	All Water	150	510	T-433	B-345

smaller		Systems				
2-1/2" & larger	Check Valve	All Water Systems	150	1400 Series	W-920-W	Stockham 'Duo-Check' Victaulic 716 / W715
2" to 12" (below ground)	Hub End	(AWWA)	150	--	-- 2380-5	Mueller
1-1/2" & smaller	Lubricated Gas Cock	Natural Gas	150	BB2-100		Rockwell 1796 & 142 With Wrench
2" & larger	Lubricated Gas Cock	Natural Gas	150	--		Rockwell 143 & 1797 With Wrench
2" & smaller	Isolation Ball Valve	Natural Gas	150			Spirax Sarco Model 60

Valves 8" and larger, and valves used for balancing service regardless of size, shall have heavy-duty weatherproof encased gear operators.
Requires extended stem in insulated lines.
** Requires ball drip assembly.

2.7 UNIONS:

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to Watts.

C. Unions are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)

D. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a dielectric coupling or waterway fitting shall be used at the transition.

2.8 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. Flange Gaskets

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets for all other applications: Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

3. Spares - Contractor shall provide ten spares for every flange size and rating.

D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

Nominal Bolt Dia. (Inch)	Torque (Ft-Lbs)
.25	6
.3125	12
.375	18
.4375	30
.5	45
.5625	68
.625	90
.75	150
.875	240
1	368
1.125	533
1.25	750
1.375	1020
1.5	1200

3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

PART 3 EXECUTION

3.1 Refer to other Sections for service specific requirements.

3.2 EXAMINATION

A. Verify excavations under provisions of Section 23 0000.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.3 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel, grooved or plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges, grooved joint couplings or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. Paint all exposed uninsulated pipe.

F. Provide all expansion loops, expansion joints, offsets, guides and anchors required to allow for expansion without damage to piping or building and to eliminate objectionable noise.

G. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

A. Provide pressure/temperature test port in a straight run of pipe adjacent to each temperature or pressure sensor installed in the hydronic piping and at the inlet and outlet of each pump and coil to facilitate proper calibration and maintenance.

3.1 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

1. For water systems with steel piping, use adequate numbers of Victaulic Style 177 flexible couplings in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. (In accordance with Victaulic instructions and as approved by the engineer.) Where expansion loops are required, use Victaulic flexible couplings on the loops

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

I. Provide support for utility meters in accordance with requirements of utility companies.

J. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Division 09.

K. Excavate in accordance with Section 23 0000 for work of this Section.

L. Backfill in accordance with Section 23 0000 for work of this Section.

M. Install bell and spigot pipe with bell end upstream.

N. Install valves with stems upright or horizontal, not inverted.

O. All equipment shall have isolation valves and be provided with unions or flanged connections for maintenance or repair.

3.2 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

End of Section 23 2100

SECTION 23 29 23
VARIABLE SPEED DRIVES

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Variable Speed Drives

1.3 RELATED SECTIONS

A. Section 23 0513 - Motors

B. Section 23 0548 - Vibration Isolation

C. Section 23 0923 – Direct Digital Control Systems

D. Section 23 0993 – Sequence of Operation

E. Section 23 3400 - Fans

F. Section 23 7300 –Fan Coil Units

G. Section 26 0519 - Cable, Wire and Connectors, 600 Volt

H. Section 26 2726 - Wiring Devices and Floor Boxes

I. Section 23 2000 - Pumps

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices

G. NEMA MG1 - Motors and Generators

H. NFPA 70 - National Electrical Code

I. IEEE - 112B, 587 and 519

1.5 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Submit sound power level data for casing radiation over full operating range, as tested and certified per AMCA standards.

3. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

D. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 0000.

B. Maintenance Data: Include instructions for routine service, spare parts lists, and wiring diagrams.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 0000.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.9 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Toshiba

C. Danfoss

D. Yaskawa

E. Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.2 GENERAL

A. Furnish and install complete Pulse Width Modulation (PWM) using variable voltage, variable frequency (VVD) speed controllers, as specified herein. All of the variable speed controllers shall be supplied by one manufacturer for this project. Motors must have a "three contactor bypass" as specified herein, to allow them to run if the controller malfunctions. All safety devices shall be energized. If an equal is proposed and accepted, Contractor must include installation and start-up by manufacturer's authorized personnel. All packages shall be factory assembled and tested.

B. The Contractor shall furnish and install Variable Speed Drive motor controllers to vary the speed of the supply, return and relief air fans and pumps as shown in the fan and pump schedules on the Drawings. One controller shall control the speed of one motor only. See schedules and Drawings for quantity of controllers required.

C. The variable speed drives shall be equipped with proper filtration devices for the distance from the motors. Refer to the drawings for distances. The exhaust fans specifically will require filtration.

D. The variable speed drive shall produce an adjustable AC voltage and frequency output for complete motor control using solid-state technology. The VSD shall be automatically controlled by a grounded electronic (0-10 VDC) control signal. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load. The VSD shall be self-contained totally enclosed in NEMA 12 ventilated cabinet and capable of operation between 0 degrees and 40 degrees Celsius.

E. VSD's shall be ETL or UL listed. All components used on option units shall be UL listed and NEMA or IEC rated. VSD's shall be designed to meet IEEE-587 and shall comply with all applicable provisions of the latest revision of the National Electric Code. The VSD shall comply with IEEE-519 with respect to the line noise generation.

F. The controllers shall be suitable for use with both new and used standard, high efficiency and premium efficiency 3-phase, squirrel cage, induction motors.

G. The The minimum output amperage of the VSD shall be equal to 100% or greater than the load's FLA, as shown in the schedules. The VSD shall have an overload capacity of at least 120% for 60 seconds, 110% continuous.

H. All components shall be factory mounted and wired on a dead-front, grounded, freestanding or wall mounted enclosure arranged for top or bottom conduit entry.

I. The controller enclosure shall be provided with the manufacturer's illustrated operating instructions and parts list mounted inside the enclosure door.

J. PWM controllers shall be designed to provide stepless motor control from 5 percent to 100 percent of base speed.

K. 480/120 Volt control power transformer for control circuits shall have two fuses on the primary and one fuse on the secondary.

L. The VSD shall have an electronic output current overload limit, adjusted to protect the VSD. This protection shall be coordinated with the bimetallic motor overload relay provided in the bypass compartment to protect the motor in all modes.

M. The frequency of the carrier frequency for the PWM control shall be programmable to prevent resonance in the mechanical system, or other methods of controlling motor noise shall be provided. Sound enclosures over the motor are not acceptable. The VSD shall also provide a feature for excluding or jumping bands of resonant sine-coded frequencies or future control connections to add this cost at a later date.

N. The VSD shall have independently adjustable acceleration and deceleration circuits of minimum range, 5 to 120 seconds adjustable minimum and maximum speed limits. Extended time periods are also acceptable.

O. The VSD shall have user programmable auto-restart after power failure, power surge, or overcurrent. VSD shall shutdown after multiple restarts. VSD shall provide fuseless electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause breaker or fuses to open. In case of an output ground fault or similar abnormal output condition, the VSD shall be fully operational after clearing the output fault condition and resetting the VSD.

P. The VSD must be able to start a load free-wheeling in either direction.

Q. Under all conditions the drive shall be able to withstand the opening or closing of a disconnect on the drive output without damage.

R. All control adjustments shall be made without the necessity of an extender board or specialized meters, but rather from front access controls.

S. Low voltage logic and 120V control circuits shall be physically isolated from the 480V power circuits. Signal circuit commons shall be grounded at the receiving end.

T. The VSD shall include a power ride-through feature to allow continuous operation through up to a three cycle line loss.

U. The drive shall not be phase sequence sensitive.

V. Components shall be pretested and each complete VSD shall have a full load factory burn-in and electronic overload test.

W. The VSD shall provide the following minimum performance:

X. Minimum of .95 efficiency, at all speeds.

Y. Minimum of .95 displacement power factor and .85 true power factor at all speeds.

2.3 FEATURES

A. The VSD shall incorporate the following minimum features:

1. Input power: 460 V/3 phase/60 Hz.

2. Inputcircuit breaker.

3. Input line filter capable of protecting the electronics against transient voltage spikes or notches, as well as backfeed of RF (Radio Frequency) interference, into the incoming power supply.

4. Fuseless electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.

B. The following door mounted devices:

1. "Power on" light

2. Hand/off/auto (or equivalent) selector switch

3. Manual speed control during hand operation

4. Inverter/Bypass mode selector switch

5. Digital display unit

6. Status, frequency/percent speed and fault diagnostics

7. Door interlocked Main Input Disconnect Switch, lockable in the off position

C. The Cabinet shall contain grouped terminals for control signals:

1. Input electronic signal, Process Feedback to control speed

2. Output electronic signal to report frequency.

3. Output contact to open on VSD Fault, Motor Overload, or External/Life Safety shutdown.

4. Start-Stop.

5. Input contact to open for External/Life Safety shutdowns.

6. The Drive Package must be capable of External/Life Safety shutdown whether in the drive or in the bypass mode.

7. If the VSD manufacturer recommends, the cabinet shall contain a Test selector switch to facilitate static testing of the drive at startup or while the motor operates in the bypass mode. This switch should be mounted inside the cabinet for technician access.

2.4 DISCONNECT AND INTERFACE

A. The following shall be mounted within the enclosure:

1. Line, load and bypass contactors capable of interrupting the locked rotor rating of the driven motor. Bypass and load contactors must be mechanically interlocked to prevent simultaneous closure.

2. Overload relay

3. A dedicated terminal strip to allow the controller to be interconnected with external shutdown contacts from smoke detectors, fire detectors, damper interlocks, freeze-stats, time clocks, remote master on-off switch, energy management and control system (FCMS) and input signals. The system must be capable of shutdown whether in the drive or in the bypass mode by remote detectors.

4. Input Circuit Breaker

2.5 FAULT DETECTION DEVICES

A. A diagnostic display center visible from outside the Package Cabinet, providing an indication of the VSD's output frequency, and selectably the following operating and fault conditions:

1. Output current value, Amps.

2. Output frequency, Hertz.

3. Inverter status and mode.

4. Programmable internal setpoints and limits.

5. Overheating fault.

6. Low AC line voltage.

7. Current overload.

8. High DC bus voltage.

9. VSD output fault.

10. Capacitor charge status

B. The VSD shall incorporate the following Protective Features:

1. Instantaneous overcurrent trip.

2. Unit overtemperature protection.

3. High DC bus voltage, 800 VDC.

4. Low input voltage, -15%.

5. DC bus fuse protection.

6. Input surge protection, MOV, or hybrid TSS circuit.

7. Ground fault protection.

8. Phase to phase fault protection.

2.6 CONTROL

A. All control adjustments shall be made through the interface.

B. Low voltage logic and 115 V control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded at the VSD only.

C. The VSD shall include a power ride-through feature to allow continuous operation through up to a three to five cycle line loss.

D. Electronic output overload protection shall be provided. The drive shall not be phase sequence sensitive.

E. The VSD shall have independently adjustable acceleration and deceleration circuits of 5 to 120 seconds. Extended time periods are also acceptable.

F. The VSD shall have full function output current limit adjustable from 10 to 100 percent.

2.7 SYSTEM OPERATION

A. All safety devices shall operate in all modes of operation. Two switches shall be mounted on the Package Cabinet door: a two position Inverter/Bypass switch and a three position Hand/Off/Auto (or equivalent) switch. Six modes of operation will be defined by the Inverter/Bypass and Hand/Off/Auto Selector switches.

B. "Inverter selected with HOA in Off" Mode - all contactors open, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor will not operate.

C. "Inverter selected with HOA in Hand" Mode - Run contactors closed, VSD varies motor speed per setting of the manual speed control at VSD.

D. "Inverter selected with HOA in Auto" Mode - Run contactors operate per external start-stop signal, VSD varies motor speed per signal from the PI Controller. (The PI Controller combines a Process Feedback Sensor control signal with a Setpoint Reset control signal to achieve an externally controlled motor speed around a remotely resetable process value.)

E. "Bypass selected with HOA in Off" Mode - all contactors open, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor will not operate.

F. "Bypass selected with HOA in Hand" Mode - Bypass contactor closed, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor operates at full speed.

G. "Bypass selected with HOA in Auto" Mode - Bypass contactors closed, VSD 480 Volt power off, all 120 Volt and VSD Control Power on, motor operates at full speed with start-stops controlled by external start- stop signal.

PART 3 EXECUTION

3.1 As part of the purchase price and agreement, a full, unconditional, one (1) year warranty on all parts and labor shall be provided. The warranty shall include all parts, labor, shipping, field service or technician time, labor or travel expenses and verbal or written

correspondence with the VSD manufacturer or his representatives, including that which might be incidental to the proper installation and operation of the equipment.

3.2 The manufacturer's representative shall provide a list of recommended spare parts.

3.3 The manufacturer's representative shall provide terminal block to terminal block wiring diagrams coordinated with the owner to provide a complete and functional operating system. Furnish detailed drawings showing construction, dimensions, wiring diagrams and installation procedures for engineer's approval.

3.4 The manufacturer shall provide a factory trained technician to start the VSD and place it into operation.

3.5 The successful vendor shall provide for and present to the owner, at no cost to the owner, a training and troubleshooting course at the owner's location. This course shall be comprised of a minimum of two (2) days of classroom instruction for a minimum of four (4) hours per day complete with visual aids, documentation, circuit diagrams and hands-on training for a group of approximately 6 people. This course is not to be construed as a sale meeting, but rather as a school to familiarize the owner with the care, troubleshooting and servicing of the VSD.

3.6 VSD's shall be wall hung units. Contractor shall provide unistrut mounting bracket for drives. Contractor shall reinforce the wall studs with bracing as required to adequately support the drive. Installation of the VSD shall allow for clearance in front of the drive as required by the latest revision of the National Electric Code for an electrical panel.

End of Section 23 2923

SECTION 23 3100
DUCTWORK

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 WORK INCLUDED

A. Low Pressure Ducts

B. Medium and High Pressure Ductwork

C. Flue and Breaching

D. Duct Cleaning

1.3 RELATED WORK

A. Section 09 9100 - Painting: Weld Priming, Weather Resistant Paint or Coating

B. Section 23 0548 - Vibration Isolation

C. Section 23 0713 - Duct Insulation

D. Section 23 3300 - Ductwork Accessories

E. Section 23 3600 - Air Terminal Units

F. Section 23 3700 - Air Inlets and Outlets

G. Section 23 0594 - Testing, Adjusting and Balancing

1.4 REFERENCES

A. ASHRAE - Handbook of Fundamentals; Duct Design

B. ASHRAE - Handbook of Equipment; Duct Construction

C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

D. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

E. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

F. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality

G. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate

H. ASTM C 14 - Concrete Sewer, Storm Drain, and Culvert Pipe

I. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

J. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

K. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

L. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment

M. SMACNA - Low Pressure Duct Construction Standards

N. SMACNA - High Pressure Duct Construction Standards

O. UL 181 - Factory-Made Air Ducts and Connectors

1.5 REFERENCES

A. Fundamentals Handbook, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

B. Equipment Handbook, ASHRAE.

C. HVAC Duct Construction Standards, Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

D. HVAC Duct System Design, SMACNA.

E. Round Industrial Duct Construction Standards, SMACNA.

F. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).

G. Assembly and Installation of Spiral Duct and Fittings, UMC.

H. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.

1.6 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: 2 inch WG positive or negative static pressure and velocities less than 1,500 fpm.

C. Medium Pressure: 6 inch WG positive static pressure and velocities greater than 1,500 fpm.

1.7 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.8 SUBMITTALS

A. Shop Drawings shall be submitted on all items of sheet metal work specified herein. Shop Drawings of ductwork at air units shall be submitted at a minimum scale of 3/8" equal to one foot.

B. Shop Drawings shall be submitted on all other ductwork per Section 23 0000. Shop Drawings shall indicate location of all supply, return, exhaust and light fixtures from the approved reflected ceiling plans.

C. Submit shop drawings and product data under provisions of Section 23 0000.

D. Submit samples under provisions of Section 23 0000.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 0000.

B. Store and protect products under provisions of Section 23 0000.

PART 2 PRODUCTS

2.1 DUCTWORK GENERAL:

A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA Duct Manuals where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein. All exhaust ductwork including toilet room exhausts shall be constructed and leak tested as specified for medium pressure supply ducts at negative pressure.

B. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Architect.

C. All duct sizes shown on the Drawings are air stream sizes. Allowance shall be made for internal lining where required, to provide the required cross sectional area.

D. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

E. Except for special ducts specified elsewhere herein, all sheet metal used on the project shall be constructed from prime galvanized steel sheets and/or coils up to 60" in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on ten foot (10') centers with manufacturer's name and must be visible after duct is installed. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

F. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

G. Ductwork taps shall be made using bellmouth or "boot" connections, and they shall be from the side of the duct, not the bottom unless it is specifically shown on the drawings or there is at least 24" clear from the bottom of the duct to the outlet.

H. Duct shall be constructed using SMACNA latest edition. Gauges and bracing shall be so that tie rods are eliminated in all locations allowed by SMACNA.

2.2 DUCTWORK LOW PRESSURE:

A. The scope of low pressure ductwork is defined as all ductwork downstream of terminal units, return air boots and all general exhaust (not kitchen or laboratory). Construction of all low pressure duct shall be in accordance with Low Velocity Duct Construction Standards as published by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and shall be sealed and tested at 3" static with the same test procedures as medium pressure ductwork.

B. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

C. The metal gauges listed in the 2005 SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct are the minimum which shall be used for this project. It shall be noted that the Contractor is responsible that the metal gauge selected is heavy enough to withstand the physical abuse of the installation.

D. Elbows shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.

E. SEALANT: All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Polymer Adhesive "Airseal #11", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) neoprene based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

F. Testing of Low Pressure Ductwork: (Includes from zone box discharge to the connection to flex duct or the diffuser.)

1. All low pressure ducts shall be pressure tested according to SMACNA Chapter 10 test procedures. Design pressure for testing ductwork shall be six inches (2") of water. Total allowable leakage shall not exceed 1% of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all Sections shall not exceed the total allowable leakage. Testing can be done before spin-ins are installed if there is no sheetmetal ductwork after the spin-in, or an additional 1 cfm can be added to the total allowable cfm leakage for each dampered spin-in.

2. The entire system of low pressure ductwork shall be tested, excluding the VAV/Constant Volume Terminal Units (i.e. The ductwork shall be capped immediately after the Terminal Units, and tested as described above). After testing has proven that the ductwork is installed and performs as specified, the terminal units shall be connected to the ductwork and the connections sealed

with extra care. The contractor shall inform the project inspector when the joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage in the terminal unit connections/joints after the systems have been put into service, the leaks shall be repaired by: 1) complete removal of the sealing materials, 2) thorough cleaning of the joint surfaces, and 3) installation of multiple layers of sealing materials.

2.3 DUCTWORK MEDIUM PRESSURE:

A. The scope of medium pressure ductwork is defined as all ductwork downstream of all air handlers, up to and including terminal units, plus all return air ductwork connected to the AHU and laboratory exhuast. Construction of all ducts shall be in accordance with High Velocity Construction Standards as published by SMACNA. All round and rectangular duct construction, duct fittings, dampers, etc., are covered in this manual and it is to be adhered to.

1. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

2. The metal gauges are listed herein for round duct and for rectangular duct.

B. All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) solvent based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

C. Oval ducts shall be spiral flat oval or welded flat oval equal to those of United McGill Sheet Metal Company with gauges and reinforcing as recommended by the manufacturer for medium pressure or the ducts may be Shop fabricated of completely welded construction of the following gauge:

Major Axis 12 to 20	No. 24 gauge
Major Axis 20 to 30	No. 22 gauge
Major Axis 30 to 46	No. 20 gauge
Major Axis 46 to 50	No. 18 gauge
Major Axis 50 and Up	No. 16 gauge

D. Oval fittings shall be equal to those of United McGill Sheet Metal Company with requirements, sealing, etc., similar to that specified for round medium pressure work.

E. Oval duct reinforcing methods shall be submitted as Shop Drawings for approval. Reinforcing galvanized angles shall be of sizes specified for same size rectangular ducts. Galvanized angles shall be used where standing seams are specified for rectangular ducts. Attaching methods shall be shown on Shop Drawings and submitted for approval.

F. Testing of Medium Pressure Ductwork: (Includes from fan discharge through to the discharge of terminal units.)

1. All medium pressure ducts shall be pressure tested according to SMACNA Chapter 10 test procedures. Design pressure for testing ductwork shall be six inches (6") of water. Total allowable leakage shall not exceed 1% of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all Sections shall not exceed the total allowable leakage.

2. The entire system of medium pressure ductwork shall be tested, excluding the VAV/Constant Volume Terminal Units (i.e. The ductwork shall be capped immediately prior to the Terminal Units, and tested as described above). After testing has proven that the ductwork is installed and performs as specified, the terminal units shall be connected to the ductwork and the connections sealed with extra care. The contractor shall inform the project inspector when the joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage in the terminal unit connections/joints after the systems have been put into service, the leaks shall be repaired by: 1) complete removal of the sealing materials, 2) thorough cleaning of the joint surfaces, and 3) installation of multiple layers of sealing materials.

G. All exhaust ductwork, including toilet room exhausts, shall be constructed as for medium pressure ducts and shall be tested for leaks in the same manner as for medium pressure supply ducts. Testing may exclude any zoning valves as well. The duct shall be capped upstream and downstream of the valves and tested on both sides. Testing can be done before spin-ins are installed if there is no sheetmetal ductwork after the spin-in, or an additional 1 cfm can be added to the total allowable cfm leakage for each dampered spin-in. The total leakage for both upstream and downstream shall be no more than 1% of the total design cfm.

H. DUCTMATE or Ward coupling system may be used on rectangular ductwork. Contractor may (where space permits) use rectangular ductwork with DUCTMATE or Ward system in lieu of oval ductwork. Joints shall be assembled with pre-formed isobutyene gasket (min. 3/16” thick x 5/8” wide), equal to Ductmate 440 tape or McGill “Uni-Butyl” tape. After assembly, entire joint shall be coated with 20 mil thickness of Hardcast “Flex-Grip” 550. No other flange-type duct joining systems may be used. Duct gauges shall be as specified herein.

I. Rectangular 90 degree elbows shall be constructed with single thickness turning vanes. Radius type rectangular elbows shall have a centerline radius of 1-1/2 times the duct diameter or width. Contractor shall have the option to substitute short radius vaned elbows, but shall request the substitution at the time of submittal of Shop Drawings, and shall request the substitution as required in Section 23 0000. Elbows in round or oval ducts may be smooth long radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.

2.4 ELBOWS:

A. Where rectangular elbows are shown, or are required for good air flow, contractor shall provide and install turning vanes. Job fabricated turning vanes, if used, shall be fabricated of the same gauge and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Submit Shop Drawings on factory fabricated and job fabricated turning vanes. Provide turning vanes in all rectangular radius elbows and offsets.

B. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.

C. Where turning vanes are to be provided and installed as required above, in ducts of over 12" thickness (vanes are over 12" long), contractor shall provide and install Tuttle and Bailey double thickness vanes or approved equal. The installation of the turning vanes shall be as described for single thickness vanes.

2.5 FLEXIBLE DUCTS:

A. Low Pressure Insulated Flexible Duct may be used where shown on the drawings. Duct shall be made with factory preinsulated duct composed of dead soft, spiral wound, triple locked corrugated aluminum core covered with a minimum of 1-1/2" thick, 3/4 lb. density fiberglass blanket sheathed in a vapor barrier of fiberglass reinforced aluminum foil and mylar laminate. The insulation shall have a minimum "K" factor of 0.29 at 60 degrees F. mean and a vapor barrier permeability rating of 0.05 per ASTM method E96-66, Procedure A. The C factor shall be 0.24 to meet HUD requirements. The duct shall be rated for a positive working pressure of 10" w.g. and a temperature of up to 250 degrees F. The duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriters Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread, not over 15; smoke developed, not over 10. Flexible ducts shall be not more than 10' in length, shall be installed in straight runs only, and shall be Flexmaster Type TL-M for connections to terminal units and Flexmaster Type 1M for connections to diffusers or approved equal. One 90 degree bend shall be allowed in the flex to connect to the diffuser as long as a "flexFlow" elbow is installed per the manufacturer's recommendations at that location.

1. The terminal ends of the duct core shall be secured by compression coupling or stainless steel worm gear type clamp equal to Ideal Series 56 Snaplock. The fittings on air mixing devices and on sheet metal duct shall be coated with the sealant specified for low pressure ductwork, then flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with more sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts mixing box or insulation on duct. These insulation connections shall be sealed by imbedding fiberglass tape in the sealant specified for medium pressure ductwork and coating with more sealant to provide a vapor barrier. (This applies to all flex connections to diffusers, grilles, etc. when allowed on the drawings.)

B. Medium and High Pressure Insulated Flexible Duct shall be the same construction as the Low Pressure Duct, factory applied insulation of 1" minimum thickness, 3/4 lb. density with a permeability rating of 0.30. The duct shall be supported by a corrosion resistant metal spiral, or a coated spring steel helix and solid inner liner mechanically interlocked or permanently bonded to the helix wire. Ratings shall be as described for Low Pressure Duct above. Flexible ducts shall be not more than 2'-0" in length, used for alignment or sound/vibration purposes only, and may only be installed in straight runs. Flexible duct shall NOT be used for changes of direction of air flow. Installation, clamps and sealing shall be the same as specified for rigid duct.

2.6 DUCT LINER: NOTE: ALL DUCTWORK SHALL BE EXTERNALLY INSULATED UNLESS OTHERWISE INDICATED ON THE PROJECT DRAWINGS. (See Section 23 0719, for the applicable insulation specification.)

A. Where indicated on the Drawings, ducts shall have lining equal to Fiberglass Aeroflex No. 150 duct liner. Duct liner shall be one inch (1") thick unless otherwise indicated. The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with fireproof 3M #37 or St. Clair R41B adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "buttered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over twenty-four (24") in width or depth, the liner shall be further secured with mechanical fasteners. The fasteners shall be A. J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive.

The clips shall be eighteen inch (18") maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. Where ducts are lined exterior insulation will not be needed unless otherwise noted, except that the two insulations shall not lap less than twenty-four inches (24"). Dimensions given on the Drawings are metal sizes. Refer to Section 23 0000 for Flame-Spread Properties.

B. Duct liner in medium pressure ducts shall be the same except a perforated metal liner shall be used over duct liner for securement in lieu of fasteners.

2.7 ALUMINUM DUCTWORK:

A. Provide aluminum ductwork for dishwasher exhaust connecting the dishwasher and the related fan as well as the outside air to the AHU.

B. Duct joints shall be all soldered construction, one standard gauge heavier than for the same size galvanized steel ducts.

2.8 KITCHEN HOOD EXHAUST

A. Minimum 16ga black iron or Stainless steel as indicated on drawings.

B. Slope back to hood.

C. Provide access doors at all changes in direction.

D. Fire protect per NFPA and UMC.

E. Manufactured duct systems with NFPA certification for grease systems may be used in lieu of above if approved by the authority having jurisdiction.

2.9 STAINLESS STEEL DUCTWORK:

A. Applies to laboratory exhaust systems and as scheduled under “Ductwork System Applications”.

B. Stainless steel shall be 304-L, as noted in the table below, with welded longitudinal seams and welded transverse joints. Welds on exposed ductwork shall be positioned for minimum view and shall be ground and polished. Duct sealant shall not be used to seal this ductwork.

C. All ductwork risers shall be installed as vertical as possible within the constraints of the design indicated on the Drawings.

D. In all cases, the ductwork shall be installed so that the washdown water, where installed, shall drain back to the hood.

E. Metal gages shall be not less than the following:

Duct Size	Gage
30” diameter or less	18
31” diameter to 60” diameter	16
61” diameter or greater	14
Greater than 60 x 42	Comply with SMACNA

(rectangular or oval)

F. The joining of stainless steel ductwork with galvanized ductwork where indicated in the Drawings shall use ductwork construction methods specified herein for galvanized ductwork.

G. Connections to cabinets or hoods: Where approved Flexible Stainless Steel Ducting can be used in lieu of hard pipe stainless steel. Flexible Ducting shall be 316 TI Stainless Steel; Pressure rated for 12" w.g. positive and negative; UL 181, Class 0 air duct rated; Velocity Rated for 5500 FPM. Similar to Flexmaster Type SS-NL-TL.

2.10 FLUE AND BREACHING:

A. Flues: Flues for boilers shall comply with NFPA requirements for Type "A" flue as required. A UL factory-fabricated stack rated for such duty may be used or a stack fabricated of not less than 10 gauge steel, welded and insulated as specified under Section 23 0716, "Equipment Insulation", of these Specifications, including terminal caps may be used.

B. Breeching: Boiler breeching shall be in accordance with SMACNA Manual recommendations.

C. Fabricated Flues: Fabricated flues shall be 10 gauge black steel with continuously welded longitudinal and transverse joints. Provide full ring sized non-asbestos gaskets at all flanged connections. Each flue shall be constructed to allow for proper expansion and contraction. Flues shall be flashed and counterflashed with 16 gauge galvanized steel at roof penetrations. Refer to Section 23 0716 for insulation of field-fabricated flues.

D. Type "A" Flues: Factory-built flues shall be laboratory tested and listed by the Underwriters' Laboratories, Inc. for use with the specified equipment burning gas or liquid fuels as described in NFPA 211, which produces exhausted flue gases at a temperature not exceeding 1400°F under continuous operating conditions.

E. Construction: Double wall flue shall have an outer jacket of Type 304 stainless steel 0.025" thick for sizes 6" thru 24" and 0.034" thick for larger diameters. There shall be minimum one inch (1") air space between the walls. The inner gas carrying pipe shall be Type 304 stainless steel. The inner liner shall be 0.035" nominal thickness for all diameters. Flues shall comply with all national safety standards and building codes when installed according the manufacturer's preprinted installation instructions and the limits of its listing.

F. Joints: Inner pipe joints shall be sealed by use of V bands and RTV Silicone Sealant for flue gas temperature up to 600°F. For flue gas temperatures above 600°F, joints shall be sealed with V bands and High Temperature Joint Cement as outlined in the installation instructions supplied by the manufacturer.

G. Termination: Flues extending above the roof shall be terminated as required by local codes or as required by NFPA 211, whichever is more stringent and shall be a minimum of 8' above the finished roof. Wind bracing or tiebacks shall be provided as required.

H. Design: The actual design of each vent flue system shall follow the layout shown on the drawings but shall be completely laid out and calculated by the flue manufacturer to suit actual equipment served, field conditions and thermal expansion. The flue vent system shall be complete, including, but not limited to: straight sections, elbows, offsets, increasers, tees, equipment connections, supports, drains, ventilated roof thimble/flashing assembles, stack caps and other required accessories. If recommended by the manufacturer for the proposed installation a drain

section with drain piping and trap shall be provided on vertical stacks.

I. Finish: All parts of the flues which are exposed outdoors and which are not stainless steel shall be protected by one base coat and two finish coats of series 4200-4300 Rust-O-Leum Corporation heat resistant paint. Paint color to be selected by approved the Architect.

J. Flue Vent Caps: Terminate all flue vent 8' or as required by local code above finished roof level with a fluecap. Fluecaps shall be stainless steel, Breidert Type "L" Air-X-Hausters or approved equal. Units shall have birdscreen and self-flashing galvanized bases. Provide special collars or adapters as required to fit cap to flue. Coordinate details of installation with all trades.

K. Factory Fabricated Chimney Systems: The factory built modular chimney system shall be laboratory tested and listed in accordance with Underwriters Laboratories Standard UL 103 for use with building heating equipment burning gas, solid, or liquid fuels with flue gases not exceeding 1400F continuous operations and 1800F intermittent operation. It shall also be tested and listed for use as a Grease Duct in accordance with UL 1978.

L. Inner shell material shall be type 304 stainless steel for natural gas and number 2 oil fired appliances, type 316 stainless steel for coal, and number 4 and number 6 oil fired appliances. Inner shell thickness shall be .036” for 6” to 36” diameter systems and .048” for 38” to 48” diameter systems. All inner shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot welded seams are not permitted.

M. Outer shell material shall be aluminized steel with a thickness of .034” for 6” to 36” diameter systems and .052” for 38” to 48” systems. (Outer shell thickness of optional type 304 or 316 stainless steel shall be .030” for 6” to 36” diameter systems and .048” for 38” to 48” diameter systems). All outer shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot welded seams are not permitted.

N. Between the inner and outer shells there shall be a minimum 2” of 1600F rated low conductivity ceramic fiber insulation. The insulation is to be securely attached to the inner shell with steel straps and insulating pins welded to the inner shell. Stainless steel centering clips shall be welded to the outer shell to maintain the 2” spacing and ensure concentricity of the shells.

O. Breeching and chimney sections, when installed according to manufacturer’s instructions, shall comply with national safety standards and building codes. Stacks terminating above a roof must terminate as required by code or NFPA 211.

P. Chimney sections exposed to atmospheric conditions shall be protected by a minimum of one base coat and one finish coat of heat resistant paint after installation. Outer shells of type 304 or 316 stainless need not be painted.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Obtain manufacturer's inspection and acceptance of fabrication and installation of fiberglass ductwork prior to beginning of installation.

C. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with

spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

E. Connect terminal units to medium or high pressure ducts directly or with two feet maximum length of flexible duct. Do not use flexible duct to change direction. Allow for a minimum of 4 diameters of straight duct to the entrance of all terminal units.

F. Connect diffusers or troffer boots to low pressure ducts with 2 feet maximum length of flexible duct. Hold in place with strap or clamp, and seal as specified.

G. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout. Use stainless steel for ductwork exposed to view and stainless steel or galvanized steel for ducts where concealed.

H. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

I. Wrap kitchen exhaust duct with 2-hour rated wrap as detailed or provide 2-hour painting.

3.2 LOW PRESSURE DUCT SUPPORTS:

A. See Section 23 0529.

3.3 MEDIUM PRESSURE DUCT SUPPORTS:

A. See Section 23 0529.

3.4 DUCTWORK APPLICATION SCHEDULE

AIR SYSTEM	MATERIAL (2)	MINIMUM PRESSURE CLASSIFICATION
Supply and Return Systems:		
Untreated Outside Air Intake (Louver) to AHU Plenum	304L Stainless Steel	Low Pressure
Single Zone FCU Supply	Galvanized Steel	Low Pressure
Single Zone AHU Supply to Terminal Unit/Lab Control Valve	Galvanized Steel	Medium Pressure
Terminal Unit Connection	Metal Flexible Duct	As Specified
Terminal Units to Supply Air Device and Return Air Duct	Galvanized Steel (1)	Low Pressure
Exhaust Systems:		
Hood/Biosafety Cabinet Exhaust	304L Stainless Steel	Medium Pressure
Toilet and general exhaust	Galvanized Steel	Medium Pressure
Laboratory exhaust	304L Stainless Steel	Medium Pressure
Kitchen Hood Exhaust	Schedule 40 Steel, Stainless Steel or Premanufactured 2-Hour Duct	Medium Pressure
Dishwasher Exhaust	Aluminum	Medium Pressure

Notes to Table:

(1) Air device connections may be made with insulated flexible duct as specified herein. Provide hard connections where specifically shown on the drawings.

(2) Any duct exposed within occupied spaces (excluding mechanical rooms) shall be

stainless.

3.5 CLEANING OF SYSTEMS:

A. Before turning the installation over to the Owner, all ducts should be cleaned and blown free of all dust and dirt that has collected in the ducts.

End of Section 23 3100

SECTION 23 3300
DUCTWORK ACCESSORIES

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 WORK INCLUDED

A. Volume Control Dampers

B. Fire Dampers

C. Combination Fire and Smoke Dampers

D. Backdraft Dampers

E. Air Turning Devices

F. Flexible Duct Connections

G. Duct Access Doors

H. Duct Test Holes

1.3 RELATED WORK

A. Section 23 0548 - Vibration Isolation

B. Section 23 3100 - Ductwork

1.4 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

B. SMACNA - Low Pressure Duct Construction Standards

C. UL 33 - Heat Responsive Links for Fire-Protection Service

D. UL 555 - Fire Dampers and Ceiling Dampers

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 0000.

B. Provide shop drawings for shop fabricated assemblies indicated, including volume control dampers duct access doors duct test holes. Provide product data for hardware used.

C. Submit manufacturer's installation instructions under provisions of Section 23 0000 for fire dampers and combination fire and smoke dampers.

1.6 QUALITY ASSURANCE

A. Dampers

1. Acceptable Manufacturers: Louvers and Dampers, Inc., Ruskin, Nailor Industries, American Warming and Ventilating, Greenheck, Pottorff.

2. Duct Access Panels and Test HolesAcceptable Manufacturers: American Warming and Vent, Ruskin, Titus, Accudor

3. Duct access doors shall be hinged and gusseted, equipped with self-tightening latches. Access door for insulated duct shall be double thickness.

4. Flexible Duct Connections

a. Acceptable Manufacturers: Metaledge, Ventglass

5. Turning Vanes and Extractors

a. Acceptable Manufacturers: Young Regulator, Titus, Tuttle and Bailey

PART 2 PRODUCTS

2.1 DAMPERS:

A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return and exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.

C. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.

D. Volume dampers shall be equal to those of American Foundry. Blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16-gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.

E. Install all dampers furnished by the Temperature Control Manufacturer in strict accordance with the manufacturer's recommendations and requirements of these Specifications.

F. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.

2.2 FIRE AND FIRE/SMOKE DAMPERS:

A. Fire Dampers

1. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.

2. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters Laboratories labeling procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.

3. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.

4. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch water gauge.

5. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch by 1 1/2 inch by 14-gauge and bolted, tack welded or screwed to the sleeve at maximum spacings of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6" water gauge static pressure.

6. The damper installation shall be in accordance with the damper manufacturer's instructions.

7. All fire dampers shall comply with the specification as written above and shall be Ruskin Model IBD2 (Style C, CR or CO), Greenheck Model FD-150 (Type C, CR or CO), or Pottorff.

8. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.

9. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design airflow at the point of installation. The minimum closure pressure rating shall be 8” wg for airflow in either direction.

B. Combination Fire/Smoke Dampers

1. Furnish and install where shown on the Drawings, or as required by the Specifications, combination fire/smoke dampers meeting the following requirements.

2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a

complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gauge pressure and 8 cfm per square foot at 4 inches water gauge pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.)

3. The damper frame shall be a minimum of 20-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14-gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees F. The jamb seals shall be flexible stainless steel compression type or lap seal type.

4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of either 20-gauge for dampers where neither width nor height exceeds 48 inches or 16-gauge where either dimension equals or exceeds 48 inches.

5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.

6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat/releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.

7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor. Dampers actuator shall be 120V.

9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 4" W.G. static pressure.

10. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin Model FSD-60, Greenheck Model FSD-33, or Pottorff.

11. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.

12. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 4” wg for air flow in either direction.

C. Submittal and Installation

1. The air quantity and free area through each fire and combination fire and smoke damper has been noted on the drawing adjacent to the duct size or wall opening size where such damper is required.

2. Submittal(s) for fire and combination fire/smoke dampers shall include the following:

   a. Assign identification numbers for each damper with corresponding number noted on the drawings.

   b. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper.

   c. Provide manufacturer's data of damper and its accessories or options.

3. One sample 18" x 12" damper shall be furnished for the purpose of illustrating damper operation to the Owner's operating and maintenance personnel.

4. Access doors as specified elsewhere shall be provided to make all parts of the damper accessible. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

5. Contractor shall install each damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555.

6. After each fire damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to the installation of the ceilings, the Contractor shall, as directed by the Construction Inspector, activate part or all the dampers as required to verify "first-time" closure. Activation of the damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fusible link of the fire damper, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate. Failure of the damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

2.3 FLEXIBLE CONNECTIONS:

A. Where ducts connect to fans, including roof exhausters, flexible connections shall be made using "Ventglas" fabric that is fire-resistant, waterproof, mildew resistant and practically air tight, and shall weigh approximately thirty ounces (30 oz.) per square yard. There shall be a minimum of one-half inch (1/2") slack in the connections, and a minimum of two and one-half inches (2-1/2") distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system. This does not apply to Air Handling Units with internal isolation.

2.4 ACCESS DOORS:

A. Furnish and install in the ductwork, hinged rectangular or round "spin-in" access doors to provide access to all fire dampers mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch (1") of insulation in the door. Where the size of the duct permits, the doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors). Latches for rectangular doors smaller than 18" x 16" shall be Ventlok No. 100 or 140. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10" x 12", complete with latch and two (2) hinges, or twelve inches (12") in diameter. Round access doors shall be "Inspector Series" spin-in type door as manufactured by Flexmaster USA, or approved equal. Doors for personnel access to ductwork shall be nominal twenty-four inches (24") in diameter.

B. Where these access doors are above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors.

2.5 SCREENS:

A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are, outdoors. Screens shall be No. 16-gauge, one-half inch (1/2") mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.6 TEST OPENINGS:

A. Furnish and install in the return air duct and in the discharge duct of each fan unit Ventlok No. 699 instrument test holes. The test holes shall be installed in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc.

2.7 LOW PRESSURE TAPS (Conical Bell Mouth Fittings)

A. Conical fittings may be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles), even though a volume damper is specified for the air device. (This does not apply to medium pressure duct.) Spin-in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin-in fittings in the ducts shall be determined after dual or single duct terminal units are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.

B. The conical fitting shall be made of at least 26-gauge galvanized sheet metal. The construction to be a two-piece fitting with a minimum overall length of 6 inches and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.

C. Each to be provided with minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.

D. Provide flange and gasket with adhesive peel-back paper for ease of application. The fitting shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on-center with a minimum of four screws per fitting.

E. The conical bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions.

B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers only where indicated.

C. Provide balancing dampers on medium and high pressure systems where indicated. Refer to Section 23 3600 and 23 3613 - Air Terminal Units.

D. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

E. Demonstrate re-setting of fire dampers to Owner's representative.

F. Provide backdraft dampers on exhaust fans or exhaust ducts where indicated.

G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

H. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.

I. Provide duct test holes where indicated and where required for testing and balancing purposes. Refer also to Section 23 0593.

End of Section 23 3300

SECTION 23 3400
FANS

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Backward inclined centrifugal fans.

B. Airfoil centrifugal fans.

C. Radial centrifugal fans.

D. Tubular centrifugal fans.

E. Inline centrifugal fans.

F. Utility/vent sets.

G. Motors and drives

H. Fan Accessories.

1.3 RELATED WORK

A. Section 23 0000 - Basic Mechanical Requirements.

B. Section 23 0513 - Motors.

C. Section 23 0548 - Vibration Isolation.

D. Section 23 0713 - Ductwork Insulation.

E. Section 23 2923 – Variable Speed Drives

F. Section 23 7300 - Air Handling Units With Coils.

G. Section 23 3100 - Ductwork.

H. Section 23 3300 - Ductwork Accessories: Backdraft dampers.

I. Section 26 0519 - Cable, Wire and Connectors, 600 Volt.

J. Section 26 2726 - Wiring Devices and Floor Boxes.

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. AMCA 99 - Standards Handbook.

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data.

F. NEMA MG1 - Motors and Generators.

G. NFPA 70 - National Electrical Code.

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

C. Product Data: Submittal data for approval for all fans of every description furnished under this section of these Specifications driven by 5 (five) HP and larger motors shall include the following:

1. Fan curves with specified operating point clearly plotted. The recommended range of operation shall be stable.

2. Data to substantiate that fans on double duct systems will operate in a stable range at 1/2" (one-half inch) S.P. above scheduled static pressure with motors sized accordingly.

3. Fans shall be capable of operating stably at reduced loads imposed by means of variable speed drives.

4. Data on sound power levels for both fan inlet and outlet at rated capacity.

5. Electrical characteristics and connection requirements.

6. All data on fan accessories.

D. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 0000.

B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 0000.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

1.9 EXTRA MATERIALS

1.10 Furnish under provisions of Section 23 0000.

A. Provide two sets of belts for each fan, not including the set installed on the fans. Tag sets to identify fan.

PART 2 PRODUCTS

2.1 GENERAL

A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Conform to AMCA 99.

D. Performance Base: Sea level conditions.

E. Temperature Limit: Maximum 300 degrees F.

F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

2.2 EXHAUST FANS:

A. Belted and direct drive vent set exhaust fans shall be Cook, Acme, Greenheck, Penn Barry or approved equal. The fans shall be complete with belt guards (where applicable), heavy duty gravity shutters, vari-speed drives, drain holes in scroll, flanged inlet and outlet connections, etc. Motor mounts shall be adjustable for proper alignment and adjustment of belts. Furnish with a factory applied prime coat of paint. Fans shall be AMCA rated.

B. Inline exhaust and supply fans shall be Cook, Acme, Greenheck, Penn Barry, in line centrifugal or vane axial as approved. Capacity ratings shall be based upon tests performed in accordance with AMCA Standard 210. Each fan shall carry near the unit nameplate the AMCA seal indicating that capacity ratings are certified. Housings for all inline fans shall be of 14 gauge steel minimum and shall have square mounting frame of heavy steel angle to provide for mounting of fan. The fan housing will provide for slip joint duct connection. Fan wheels shall be axial flow type with cast aluminum blades or tubular centrifugal type constructed of welded steel and have airfoil shaped blades. The fan shall be dynamically balanced for smooth operation. The fan shaft shall be solid be solid steel AISI-C1040 keyed to the fan wheel. Grease lubricated bearings shall be selected for a minimum average life in excess of B-10, minimum life 40,000 hours at maximum catalogued operating conditions. Fans shall be provided with factory mounted inlet and outlet sound attenuators when required to meet the scheduled sound power levels. The increased pressure drop due to attenuation must not cause an increase in power requirements from those

specified. If oversized slow speed units are required, the Contractor shall be responsible for any related extra costs, not coming under his contract.

C. Propeller or centrifugal roof exhaust air and supply air fans shall be Cook, Acme, Greenheck, Penn Barry or approved equal. The fans shall be complete with fans and motors, propeller, motorized shutters factory wired to open when fans are in operation and close when fans are not in operation, nonfused disconnect switches, bird screens, and round spun aluminum weatherproof protection covers. Fans shall be all aluminum. The fans shall be firmly bolted to the curb on which they rest. Fans shall be AMCA rated. Wing nuts of nonferrous construction shall be provided to remove covers.

D. Propeller wall fans shall be Cook, Acme, Greenheck, Penn Barry or approved equal, belt or direct driven as scheduled on the Drawings. The fans shall be complete with guards over motor side, heavy duty gravity shutters, etc. Furnish with a factory applied prime coat of paint. Fans shall be AMCA rated.

2.3 CENTRIFUGAL HIGH PLUME EXHAUST FANS

A. Fans shall be configured as belt driven per AMCA Arrangement 1, 9, 10 or direct drive per AMCA arrangement 8 according to the Drawings. Fans mounted on top of exhaust air plenums or are not accessible from the roof shall be equipped with jib cranes (complete with removal hoist), for motor maintenance and removal.

B. Fan, plenum and dampers shall be coated with a minimum of 3 mils of Plastifer epoxy ES90-AS81, or Hi-Pro Polyester resin coatings. Finish color shall be light gray.

C. Fan assemblies that use flexible connectors that can fail and cause loss of laboratory containment are not acceptable. Inlet elbow/plenum shall be attached to the fan inlet by a high strength, corrosion resistant flexible connector, or vibration isolation pad or gasket, provided by the fan manufacturer.

D. Impellers:

1. Fan impeller for centrifugal fans shall use backward inclined or airfoil blade design wheel with non-stall characteristics. The impeller for either wheel design shall be electronically balanced both statically and dynamically meeting or exceeding Grade 6.3 per AMCA Standards.

2. Fan impeller shall be manufactured of welded and coated steel with a minimum of 3 mils of Hi-Pro Polyester resin, or 4-6 mils of Plastifer epoxy ES90-AS81 with a finish color of light gray.

2.4 MIXED FLOW HIGH PLUME EXHAUST FANS

A. Mixed flow steel case fans shall be direct driven in AMCA Arrangements 2, or AMCA Arrangement 4, or belt driven in AMCA Arrangement 9. Fans systems shall be equipped with jib crane (complete with removal hoist), for motor maintenance and removal.

B. Fan, plenum and dampers shall be coated with a minimum of 4-6 mils of Plastifer epoxy ES90-AS81, Hi-Pro Polyester resin or Amercoat 90HS Epoxy-phenolic coatings. Finish color shall be light gray.

C. Impellers:

1. Fan impeller for vertical inline fan shall use a combination axial / backward curve blade design wheel with non-stall characteristics. Stationary discharge guide vanes located above the impeller shall be provided to increase fan efficiencies. The impeller for either wheel design shall be electronically balanced both statically and dynamically meeting or exceeding Grade 6.3 per AMCA Standards.

2.5 EXHAUST AIR PLENUM CURBS

A. For a constant volume exhaust system, the fan / nozzle assembly shall be connected directly to roof or roof curb and exhaust duct without need for a bypass air plenum.

B. For a variable volume exhaust system, a bypass air plenum shall be provided as shown on Drawings. The plenum shall be provided with stainless steel modulating opposed blade bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air rain hood and bird screen. The actuator(s) to operate the bypass damper are to be supplied by the building automation system (BAS) Provider.

C. A parallel blade fan tight shutoff isolation damper, two position actuated, fabricated of stainless steel, shall be provided as shown on the Project documents. Isolation damper shall include a factory mounted and wired actuator; complete with a mounted and wired step down transformer, wired to the fan disconnect. Transformer shall be mounted in a NEMA 3R panel, minimum, or as shown on the Drawings. The isolation damper precludes reverse rotation of the fan wheel when the fan is not energized.

D. The plenum shall be constructed of welded cold rolled steel, and coated with minimum 3 mils of Hi-Pro Polyester resin or Epoxy-phenolic coatings.

E. Plenums that are fabricated of plastics or resin that are combustible and have mechanical properties less than steel shall not be acceptable.

F. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the Drawings

G. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be permitted.

H. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

I. Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the Drawings.

J. Curb shall be fabricated of a minimum of 12 gage corrosion resistant coated steel and structurally reinforced.

K. Vertical exhaust inlet plenums shall have curbs that are insulated. Horizontal exhaust inlet plenums shall have un-insulated plenums.

L. The plenum shall have integral drain connections to drain water that may condense on the inner wall of the plenum.

M. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

2.3 V-BELT DRIVES:

A. All v-belt drives shall be designed for a minimum of 50% overload. Where more than one belt is required, matched sets shall be used. All belt drives shall be furnished with belt guards.

2.4 RELIEFS:

A. The relief shall be as manufactured by the supplier of the roof exhausters and shall match, as closely as possible, their silhouette. Furnish complete with bird screen.

2.5 MOTORS:

A. Refer to Section 23 0513 for requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install fans with resilient mountings and flexible electrical leads. Refer to Section 23 0548.

C. Install flexible connections specified in Section 23 3300 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

D. Install fan restraining snubbers as required. Refer to Section 23 0548. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

E. Provide fixed sheaves required for final air balance.

F. Provide safety screen or cage where inlet or outlet is exposed. Plug fans inside walk-in casings shall be provided with hinged safety cage.

G. Pipe scroll drains over to nearest floor or roof drain.

H. Provide backdraft or motorized dampers on discharge of exhaust fans where indicated. Refer to Section 23 3300.

I. Provide two fan belts for each belt-driven fan.

J. Secure roof fans with cadmium plated steel lag screws to roof curb structure. Install dampers in roof curb damper tray when noted on the drawings

K. Provide hinged curb adapter to permit access to dampers and duct connection.

L. Install safety screen when inlet or outlet is exposed.

M. Fan Balancing. Provide proper fan design and balance fans and drives to limit vibration (displacement in mils) at operating speed to the values in the following table unless specified elsewhere. Measure vibration at each fan bearing, in all three planes.

End of Section 23 3400

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 WORK INCLUDED

A. Diffusers

B. Diffuser Boots

C. Registers/Grilles

1.3 RELATED SECTIONS

A. Section 09 9100 - Painting: Painting of Ductwork Visible behind Outlets and Inlets

B. Section 23 3100 - Ductwork

C. Section 23 3300 - Ductwork Accessories

1.4 REFERENCES

A. ADC 1062 - Certification, Rating and Test Manual

B. AMCA 500 - Test Method for Louvers, Dampers and Shutters

C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems

D. ARI 650 - Air Outlets and Inlets

E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets

F. SMACNA - Low Pressure Duct Construction Standard.

1.5 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate performance of louvers in accordance with AMCA 500.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.7 SUBMITTALS

A. Submit product data under provisions of Section 23 0000.

B. Provide product data for items required for this project.

C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.

D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

E. Submit manufacturer's installation instructions under provisions of Section 23 0000.

PART 2 PRODUCTS

2.1 AIR SUPPLIES AND RETURNS:

A. Grilles, registers and ceiling outlets shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 FPM nor less than 25 FPM. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level). Grilles, registers and ceiling outlets shall be Titus, Krueger or Nailor.

B. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

2.2 LOUVERS

A. Louvers shall be as specified by the Architect.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to Section 09 9100.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9100.

End of Section 23 3700

SECTION 23 73 23
AIR HANDLING UNITS

PART 1 GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 23 0000 – Basic Mechanical Requirements

B. Section 23 0529 – Sleeves, Flashings, Supports and Anchors

C. Section 23 0553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Custom Air Handling Units

B. Factory Installed Fans

C. Dampers

D. Filters

E. Coils

F. Drives

G. Humidifiers

1.3 RELATED SECTIONS

A. Section 21 0548 - Vibration Isolation

B. Section 22 1316 - Plumbing Piping: Equipment Drains

C. Section 23 0513 - Motors

D. Section 23 0516 - Expansion Compensation

E. Section 23 0713 - Ductwork Insulation

F. Section 23 2923 – Variable Speed Drives

G. Section 23 3100 - Ductwork

H. Section 23 3300 - Ductwork Accessories: Flexible Duct Connections

I. Section 23 3400- Fans

J. Section 23 4100 - Filters

K. Section 23 8216 - Air Coils

L. Section 23 8413 – Steam Grid Humidifier

M. Section 26 0519 - Cable, Wire and Connectors, 600 Volt

N. Section 26 2726 - Wiring Devices and Floor Boxes

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices

G. AMCA 500 - Test Methods for Louver, Dampers, and Shutters

H. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils

I. ARI 430 - Central-Station Air-Handling Units

J. ARI 435 - Application of Central-Station Air-Handling Units

K. ARI 610 - Central System Humidifiers

L. NEMA MG1 - Motors and Generators

M. NFPA 70 - National Electrical Code

N. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

O. UL 900 - Test Performance of Air Filter Units

1.5 SUBMITTALS

A. Submit under provisions of Section 23 0000.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.

C. Condensate Drain Calculations: Provide calculations for each condensate drain required on the unit. Provide calculations showing that there will be ample height to provide proper trapping on the units submitted with the curb height and baserail height shown on each unit.

D. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.

2. Provide data of filter media, filter performance data, filter assembly, and filter frames as

tested and certified per ASHRAE standards.

3. Provide fan curves with specified operating point clearly plotted, as tested and certified per AMCA standards. Ratings to include system effects. Bare fan ratings will not satisfy this requirement, but shall be submitted for comparison purposes.

4. Submit sound power level data for both fan outlet and casing radiation at rated capacity, as tested and certified per AMCA standards.

5. Provide data on all coils as tested and certified per ARI standards.

6. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

7. All materials shall have NFPA-90 rating of 25/50 or better.

E. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 0000.

B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 0000.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation of the Owner’s RCM.

1.10 EXTRA MATERIALS

A. Furnish under provisions of Section 23 0000.

B. Provide two sets of belts and three sets of filters for each unit. - One set of filters is to be installed when unit is started up, and shall be protected from construction debris with additional media either at the first bank of filters, or covering each air intake (outside air and return air). The second set of filters is to be installed when test and balance activities begin. At substantial

completion, HISD RCM shall inspect filters to determine if the third set should be installed or delivered to campus operations personnel. Tag to identify associated unit.

1.11 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible, all items of the same type (i.e., pumps, fans, etc.) shall be by the same manufacturer. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Temtrol

B. Carrier

C. Trane

D. York

E. McQuay

F. Energy Labs

G. AAON

H. Substitutions: Under provisions of Section 23 0000. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.2 GENERAL DESCRIPTION

A. Configuration: Fabricate with fan and coil sections as scheduled plus accessories, including:

1. Electric Heating coil

2. Mixing box section

3. Filter section

4. Cooling coil section

5. Humidifier

6. Motors and control

7. Fan or Fan Array Section

B. Performance Base: Sea level conditions

C. Fabrication: Conform to AMCA 99 and ARI 430 in the absence of direction in this specification.

D. Performance: Refer to schedule in drawings.

2.3 AIR HANDLER CASING AND GENERAL CONSTRUCTION:

A. The unit shall be constructed for outdoor construction. Piping chases shall be internal to the unit and all duct shall penetrate through the roof curb unless otherwise noted. The top of the unit shall be sloped to ensure no pooling of rainwater on the top of the unit. The pipe and ductwork may be routed on the roof at the contractor's option. All coordination with structure, penetrations into and out of chases, waterproofing and design of the routing to ensure proper clearances are met shall be done by the contractor if this options is taken.

B. The unit shall have perforated metal liner in the mixing section and the fan section for sound purposes.

C. Unit casing exterior (walls and roof) shall be a minimum 18-gauge thickness galvanized steel insulated internally, throughout (double wall construction with no thru metal). 22 gauge exterior shall be allowed when the insulation is foam injected. Internal insulation shall have an R-value of at least 12, with foil facing, neoprene or anti-microbial hardcoat protected unless specifically noted otherwise, and shall be fire and fungus proof. All internal insulation shall be protected with solid galvanized sheet metal, of a minimum of 22-gauge thickness. All sheet metal joints throughout the air handler, and between panelized sections, shall be gasketed with closed cell, soft rubber gaskets, fabricated from neoprene, EPDM, or other approved material. Internal walls and roof outside shall be sealed such that there is no passage of air from inside the unit to the outer casing.

D. Individual panels of the fan section shall be removable without compromising the integrity of the unit. Casing assembly shall be configured to eliminate all thru-metal in portions of the unit subject to below ambient temperatures. Where fasteners are used in the assembly of the unit components, they shall not extend from the outside of the unit into the air stream.

E. Drain pan liners shall be constructed of 22-gauge stainless steel or heavier as standard with the manufacturer and shall be non-skid. Drain pan shall extend past the cooling coil (leaving airside) into the fan section on draw through units. Entire drain pan shall be insulated with R-8 rigid insulation. Drain pans shall be sloped to the outside edge of the unit. On units over six feet wide, slope to each side of the unit. The insulation shall be installed and sealed as is appropriate for the equipment construction.

F. Unit shall have a complete perimeter channel base of at least 6" galvanized steel or 6" carbon steel with marine quality primer. All floors shall be insulated with R-10 insulation with 14-gauge non-skid galvanized floor(or equivalent aluminum). An 18-gauge galvanized sheet shall enclose and form a vapor barrier for the insulation on the bottom of the unit. If a foamed-in-place closed cell insulation is used, the lower metal enclosure may be eliminated. All points of contact between the floor, vapor barrier and structure shall be thermally isolated with gasketing of closed cell soft rubber or EPDM.

G. Access doors shall be provided to allow access to both sides (upstream and downstream) of the filter racks, into the fan section, and both sides of all coils. Access doors shall be double wall, insulated the same as wall panels, and the opening framed with thermal break construction. Door size shall be at least 18" wide and full height of the panel up to 5' 0" tall. The construction of the access doors shall equal or exceed the quality and quantity of the air handler casing materials as specified herein. Each door shall have a minimum of an 8-inch by 6-inch double-glazed view

window, capable of withstanding the total developed pressure of the unit. The doors shall be hinged using either heavy-duty stainless butt hinges, or a continuous stainless steel piano hinge, extending along the entire edge of the door, except for a maximum of two inches at each end. If butt hinges are used, provide two per door for up to 36" high doors and three per door for longer doors. There shall be a minimum of two latches on doors longer than 18," and three latches in doors over 36" long. Latches shall be Ventlok 310, heavy-duty latch, or approved equal. All access doors shall open against air pressure unless outdoor units or unless space is prohibitive. If doors are to swing outward in positively pressurized sections of the AHU, a secondary latch shall be provided to catch the door until pressure can equalize to avoid the door swinging into personnel due to pressure.

H. Coils in the air-handling units shall be individually removable from the inside of the unit through the access door and shall not be used to provide structural stability for the casing. All coils shall be arranged for and piped to provide counterflow operation. The coils shall be completely enclosed within the coil housing of the air unit casing. All penetrations of the air handler casing shall be neatly sealed using a resilient sealant. Hinged gasketed quick access doors of adequate size for a man to enter shall be provided for each space between coils, filters and other components. Stacked coils shall have intermediate drain pans with at least 1" rigid drain piping and pipe supports to main drain pan.

I. Panels shall be reinforced with sufficient internal bracing to prevent excessive deflection of the panels. Maximum deflection at joint on the unit casing shall be limited to L /240th of the overall panel width or height.

J. Panel construction shall provide the following acoustical performance.

Sound Transmission Loss (dB) per ASTM E-90 & E-413

Octave	2	3	4	5	6	7	STC+
Coated Liner	22	26	37	44	53	55	39
Solid Liner	22	38	49	50	57	62	42

Sound Absorption Coefficients per ASTM C-423 & E-795

Octave	2	3	4	5	6	7	NRC+
No liner	.26	.71	1.09	1.02	.96	.83	.95
Coated Liner	.25	.79	1.06	1.06	1.04	.78	1.00

1. The above ratings represent design performance. Unit manufacturer shall submit full sound performance data to the project sound consultant for evaluation. Note in submittal any octaves that exceed so that the Engineer may make corrective actions if deemed necessary. Unit shall be finally configured to not exceed the room NC values in Section 13 4800.

K. Surface Condensation per ASTM D4230 "Measuring Humidity with Cooled Surface Condensation"

Provide unit housing including joints and seams that will not condense moisture when:

$$\frac{(T_h - T_l)}{(T_h - T_{dp})} = \text{Less than } 3.3$$

where :
T_h = Higher temperature internal or external to casing (95 degrees design)
T_l = Lower temperature internal or external to casing (48 degrees design)
T_{dp} = Dew point at location corresponding to T_h (80.76 degrees design)

L. Equivalent aluminum material may be used where galvanized steel panel components are called for.

M. Provide sealable test ports on either side of each filter bank and each coil section, in inlet plenum and discharge plenum, and suction and discharge side of all fans. Ports shall be equal to Ventfabrics test port Model 699-2.

2.4 SINGLE FAN SYSTEMS: (See also Section 23 34 16)

A. Shall be both dynamically and statically balanced. Housed fans shall be equipped with quick opening access doors in the fan scroll. Motors shall be high efficiency type per Section 23 0513. The motor mounting for each unit shall be an integral part of the fan support frame. The fan/motor unit shall be mounted on spring isolators within the air handler casing. Housed fans shall have an appropriately designed fabric duct vibration isolator installed within the air handler casing. The unit shall be supplied with a factory installed and sealed flange for connection to ductwork. For belt drive units, manufacturer shall provide fixed sheave on units of 10 HP and larger. Contractor shall provide one additional sheave set, size to be determined after job-operating conditions are known. The additional sheave set shall be of equivalent quality to that originally installed by the manufacturer.

B. The fan unit bearings shall be of the antifriction type, either ball or roller, lubricated at the factory, and shall be equipped with means for lubrication with a grease fitting on the outside of the bearing housing. Both inboard and outboard bearings shall be the same, identical size. The bearings shall be a catalogued type as manufactured by Fafnir, SKF, Sealmaster, or approved equal, and stocked locally. Bearings shall have an L-50 minimum life of 200,000 hours. Intermediate bearings will not be acceptable. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where it is not possible, then the fitting shall be mounted where it is most easily accessible for service. The tubing used for remoting the fitting shall be stainless steel, installed with a strain relief pigtail approximately 4 inches in diameter and located on the drive side of the assembly.

C. The unit manufacturer shall balance the fan (per ANSI/AMCA 204-96 fan application category BV-3) at design fan speed with belts and drives in place to a vibration velocity less than or equal to 0.157 inches (0.100 inches for direct-drive applications) per second measured on horizontal, vertical, and axial planes at each bearing pad. Vibration amplitudes are in inches/second peak velocity. All values recorded are to be filter-in at the fan speed.

D. Plug fans installed in walk-in units shall be provided with a safety cage around the wheel or with a fan shut down switch in the access door. Cage shall be large enough to allow working room for wheel and bearing service and shall have removable sections to allow wheel removal.

2.5 DAMPERS

A. Mixing Boxes: Section with factory built, factory mounted outside and return air dampers of galvanized steel and edge seals in galvanized frame, with galvanized steel axles in

self-lubricating nylon bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension. Provide removable, full width rack for supporting freeze protection thermostat, with removable end panel to permit rack removal.

B. Damper Leakage: Dampers shall be provided to meet the requirements of the low-leakage dampers as noted in ductwork accessories.

C. Refer to Section 23 3300 for additional requirements.

2.6 DRIVES:

A. V-belt drives: Shall be designed for a minimum of 50% overload. Where more than one belt is required, matched sets shall be used. All belt drives shall be furnished with belt guards or door interlocks. If belt driven fans are used, the motor shall have no less than 2 belts each.

B. Variable speed drives: See Section 23 29 23. Drive supplied shall be tested at the AHU factory with motor provided and balanced. This testing shall be witnessed by a representative of the Owner's Test and Balance Consultant.

2.7 COILS:

A. Refer to Section 23 8216 - Air Coils, and Unit Schedules for requirements.

2.8 FILTERS:

A. Refer to Section 23 4100 - Filters, and Unit Schedules for requirements.

2.9 ELECTRICAL

A. Fan motors shall be factory-mounted and wired to an external disconnect switch adjacent to the motor access door. Fan motors shall be interlocked with fan access door to shut down when door is opened.

B. Vapor proof lights (ceiling or wall mounted so that fixture shall be no higher than 88" above floor) shall be provided in each compartment with access doors. Lights shall have a switch at each door into the compartment. Provide two GFI convenience outlets evenly spaced on the long dimension of the unit. Wire lights and outlets to two external 120v, 20a power connections (one for each service) for connection by Division 26.

C. All wiring shall be 600v rated type MTW/THWN stranded copper or LiquidTite conduit (max 3 feet). All junction boxes shall be UL approved and gasketed.

D. Motors – see Section 23 0513 for additional requirements.

2.10 FINISH

A. All external parts of the unit shall be Brite G-90 galvanized. No painting will be required, but factory painting is acceptable.

PART 3 EXECUTION

3.1 INSTALLATION

A. Field assembly of the unit shall be the responsibility of the manufacturer.

B. Install in conformance with ARI 435.

C. Assemble high-pressure units by bolting sections together.

3.2 TESTING

A. Units with cabinet mounted fans shall be tested and certified at rated conditions using AMCA 210 and AMCA 300 test procedures with fan mounted in the cabinet. Bare fan data will not be accepted.

B. Casing Deflection Test

1. Deflection limit of L/240 shall be demonstrated in the factory prior to shipping and witnessed by a representative of the Owner's Test and Balance Consultant.

2. 'L' is defined as the height of the largest panel on the sides, width across the top of the largest panel on the unit, and the smaller of width or height of the largest panel for the ends. These are known as the governing panels.

3. That entire unit shall be tested under positive pressure.

4. Measurements shall be taken at mid point of 'L' using dial indicators reading in 1/1000ths. Mounting of dial indicators shall be independent of the unit casing. Multiple measurements shall be made. Dial indicator shall be mounted at mid point of 'L'. Measurements shall then be spaced along the sides, ends and top at mid point and quarter points of the negative section and the positive section. Spacing shall be adjusted to fall on nearest flange or panel joint. Any section of less than five feet shall require only one measurement at the center.

5. Unit shall be furnished with proper blank offs to facilitate the pressure testing.

6. In order to reduce the number of pressure cycles, it is recommended that multiple dial indicators be used at the measurement points. Separate set-ups will be required for the positive pressure tests and the negative pressure tests.

C. Casing Leakage Test. With unit set in place, leveled and ready to receive duct work connections, unit shall be tested for casing leakage by sealing all openings and pressurizing to 2.5 times rated pressure (defined as the maximum positive or negative pressure that the unit is designed to see at any point) or 10" WG, whichever is smaller. Maximum allowable leakage rate is 1.5% of rated unit flow. Test is to be performed by the manufacturer using flow measurement devices and shall be witnessed by a representative of the Owner's Test & Balance firm.

D. Fan/Motor Vibration Test. With the unit set in place, leveled, and ductwork attached, the manufacturer shall perform a final dynamic vibration trim balance to verify the fan/motor vibration velocity limit over the following operating speed range: Fans with VFDs shall be checked from 40 to 110% of the rated fan speed. Constant speed fans shall be checked at 100% of rated fan speed. 'Lock-out' ranges may be used to correct up to two ranges of excess vibration. The span of each 'lock-out' range shall be limited to an effective fan speed of 50 RPM. Any 'lock-out' range used shall be clearly identified in the test report and shall be prominently displayed on a typed, laminated legend mounted inside the VFD controller cabinet. This testing shall be witnessed by a representative of the Owner's Test and Balance firm.

E. Failure of the leakage and/or deflection test shall require sealing and bracing of the unit and retesting until criteria is met. Failure of the trim balance to confirm vibration limit shall require rebalancing and re-testing until criteria is met. Contractor shall bear all costs involved in the

modifications, balancing, and re-testing, including travel and hourly costs associated with the representatives of the Owner's Test and Balance firm.

F. Due to the units being located outdoors, the casing and leakage testing on-site shall be done with a representative of the Engineer present for sign-off.

END OF SECTION 23 73 23

SECTION 23 82 33
ELECTRIC HEATING COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 01 00, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide duct-mounted electric heating coils as scheduled, specified, and required for the project.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Brausch.
2. Indeeco.
3. Magna-Flow.
4. Redd-i-Heat.
5. Warren.

B. UL Listing: Coils shall be UL-listed and labeled for zero clearance installation and shall meet all applicable NEC requirements.

C. SMACNA Compliance: Comply with Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) standards.

D. Industry Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to HVAC coils, except as otherwise indicated.

1.4 SUBMITTALS:

A. Submittals: Shop drawing submittals shall include, but not be limited to , the following:

1. Cut sheets on electric heating coils, clearly marked to show coil sizes, construction, features, and other pertinent information.
2. Coil selections clearly indicating coil sizes, capacities, ratings and pressure drops.
3. Manufacturer's recommended installation instructions.
4. Additional information as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver duct heaters in factory-fabricated water-resistant wrapping.

B. Handle duct heaters carefully to avoid damage to tubes, fins, and casing.

C. Store duct heaters in a clean, dry space, and protect from weather.

PART 2 - PRODUCTS

2.1 ELECTRIC DUCT HEATERS:

A. General: Provide electric duct heaters with air flow, heating capacities and electrical characteristics as scheduled or shown on the drawings. Heater shall be of a slip-in design and shall be suitable for side or bottom installation in externally insulated or internally lined sheetmetal ductwork. The element frame and control panel shall be fabricated of galvanized or aluminized steel.

B. Heating Elements: Shall be high grade 80/20 nickel chromium with ceramic insulators. Element wires shall not glow when operating at rated capacity. Heaters over 47 inches in any dimension shall have protective screens on the inlet side. Multi-stage heaters shall have their elements split by rows.

C. Thermal Protection: Heater shall have disc type automatic reset thermal cutouts for primary protection and fusible links for secondary protection.

D. Control Panel: All unit control and electrical connections shall be installed in an internally insulated factory wired control panel with a hinged and gasketed cover. Control shall include, but not be limited to, fusing for all stages, magnetic contactors, primary and secondary fused control panel transformer, [PE switches,] time delay between steps and differential air pressure switch. All components shall be factory wired and only field connections for electric power and [pneumatic] controls will be required. [Settings for PE switches shall be coordinated with the Temperature Controls Subcontractor.] Control panels for use with lined duct shall be recessed so that the entire surface of the heating elements is in the air stream. An accurate wiring diagram shall be permanently attached to the inside of the control panel door.

E. Disconnect Switches: Shall be furnished and installed under Division 26.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install electric duct heaters in accordance with the manufacturer's written instructions, the applicable portions of SMACNA and recognized industry practices, to ensure that products serve the intended functions.

B. Duct Installation: Where heaters are installed in ductwork, a sheet metal channel shall be inserted in the duct on all three sides of the heater to support the heater. Where the heater cross-sectional area is less than the duct cross-sectional area an equalizing grid shall be installed on 3 sides of the heater per SMACNA guidelines. Transitions shall not be used. The grid shall be either galvanized wire mesh or a perforated galvanized sheetmetal plate and shall have approximately the same pressure drop as the heater. The grid shall be securely fastened to the duct and heater frame. Where heater cross-sectional is larger than the duct cross-sectional area, the duct shall be transitional to the larger size and then transitioned back, in accordance with SMACNA guidelines.

C. Cleaning: Clean dust and debris from each coil as it is installed to ensure its cleanliness.

3.2 FIELD QUALITY CONTROL:

A. Repair: Repair or replace damaged coils as required.

3.3 INSULATION:

A. General: Non-factory insulated casing shall be insulated as specified in Section 23 07 00.

3.4 IDENTIFICATION:

A. Refer to Section 23 03 00, for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 82 33

DIVISION 26 – ELECTRICAL

26 00 01 - Electrical General Provisions

26 05 01 - Electrical Basic Materials and Methods
26 05 19 - Low Voltage Conductors and Cables
26 05 26 - Grounding and Bonding for Electrical Systems
26 05 33 - Electrical Raceways
26 05 34 - Electrical Boxes

26 05 53 - Identification for Electrical Systems
26 05 73 - Short Circuit Analysis/Coordination Study

26 22 00 – Low Voltage Transformers

26 24 16 - Panelboards

26 27 17 - Equipment Wiring
26 27 18 - Miscellaneous Electrical Controls and Control Wiring
26 27 26 - Wiring Devices

26 28 13 - Low Voltage Fuses
26 28 18 - Enclosed Switches

26 32 13 - Engine Generators

26 36 23 - Automatic Transfer Switches

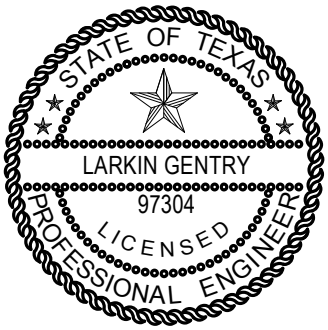
26 41 13 - Lightning Protection for Structures

26 51 00 - Interior Lighting
26 56 00 - Exterior Lighting

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 31 03 - Addressable Device Fire Alarm System

E&C Engineers & Consultants, Inc.
TX Firm Registration No: F-003068
Date: 12-30-2024
Engineer of Record: Larkin Gentry
State: Texas
License no: 97304



THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY:

Larkin Gentry
2024.12.30
10:55:38-06'00'

E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

SECTION 26 00 01 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and this Section govern the work of this Division.

1.2 DESCRIPTION OF WORK:

A. Work Included: This Work of this Division includes the furnishing of all supervision, labor, materials, supplies, equipment, fixtures, apparatus, appurtenances , transportation, storage, utilities, permits and licenses required for complete installation of complete, tested and operating electrical systems as shown on the drawings and specified or as reasonably inferred there from, in place and ready for service. Refer to Section 26 00 02, "Electrical Scope of Work", for additional requirements. All work performed under this Section shall be performed in a workmanlike manner in accordance with the Drawings and Specifications and industry standards and subject to the terms and conditions of the Contract. For purposes of these Specifications, "provide" and "furnish and install" shall be synonymous.

B. Drawings: Refer to the Electrical Drawings for graphic representations, schedules, and notations of required electrical work.

C. Specifications: Refer to this Division and related Divisions for the primary technical specifications of electrical work.

D. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs; but subject to the requirements of this Section to the extent applicable.

1. Finish painting of electrical systems in areas exposed to the view of building occupants is specified in other Divisions. All prime and protective painting for all areas shall be provided under this Division.
2. Installation of electrical control power which is not specified as an integral part of equipment specified under Divisions 21, 22, 23 and 25 shall be provided under this Division.
3. Access doors in finished surfaces shall be provided under this Division and installed by the Contractor installing the finished surface. Locations are shown on the Drawings and as required for proper equipment access.
4. Concrete housekeeping pads, curbs, ductbank encasement and supporting structures are specified under this Division**.** Dimensions and locations of pads and supports shall be the responsibility of this Division.
5. Owner and General Contractor-furnished equipment is furnished and installed under other Divisions. Proper electrical provisions, including rough-in and final equipment connections, are included in the Work of this Division.

6. Motors for all equipment shall be furnished and installed by the Division(s) providing the equipment.
7. Motor starters and controllers that are furnished as an integral part of the equipment shall be furnished and installed by the Division(s) shall be wired and connected by this Division.
8. Variable speed drives which are furnished with controlled equipment shall be provided by the Division(s) providing the equipment to this Division for installation, wiring and connections by this Division.
9. All other motor starters and associated electrical wiring and connections are included in the Work of this Division.

1.3 CODES, PERMITS AND FEES:

A. General: Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities. Where alterations to and deviations from the Contract Documents are required by said authority, report the requirements and secure approval before starting work. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.

B. Code Design Basis: The following codes and ordinances were used in the design of the project and shall be complied with during construction of the project.

1. Building Code – International Building Code, 2021 Edition.
2. Fire Code – International Fire Code, 2021 Edition.
3. Electrical Code – National Electrical Code, 2020 Edition.
4. Mechanical Code – International Mechanical Code, 2021 Edition.
5. Plumbing Code – Uniform Plumbing Code, 2021 Edition.
6. Energy Code – International Energy Conservation Code, 2021 Edition.
7. Accessibility Code- Americans with Disabilities Act of 1990.

C. Precedence: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule. Any modifications resulting there from shall be made without additional cost to the Owner or Engineer. This Contractor shall report any such modifications to the Engineer and secure his approval before proceeding.

1.4 QUALITY ASSURANCE AND STANDARDS:

A. Materials/Methods: Manufacturers, materials, and methods described in the various sections of the Specifications, and indicated on the Drawings are intended to establish a standard of quality only. It is not the intention of the Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed

as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Specifications and space constraints. **The Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.**

B. Alternative Products/Materials/Methods: Products by other reliable manufacturers, other materials, and other methods may be accepted provided they have equivalent capacity, construction, and performance. **Under no circumstances shall any substitution be made without the prior written approval of the Engineer.** Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Engineer that the specified product, material or method is the only one that shall be used without prior approval. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be provided, it is the intention of the Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without prior written approval.

C. Alternative Equipment: Where substituted or alternative equipment is used on the project, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available, including all required Code and maintenance clearances, and to coordinate all equipment requirements and provisions with the Electrical Design and all other Contractors and Subcontractors.

D. Compatibility: Provide products which are compatible with other products of the electrical work, and with other work requiring interface with the electrical work, including electrical connections and control devices. For exposed electrical work, coordinate colors and finishes with other work. Determine in advance of purchase that equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearance as required by applicable codes and for adjustment, repair, and replacement.

E. Standards: Refer to Divisions 0 and 1 for general administrative/procedural requirements related to compliance with applicable standards. This Work and all materials shall meet the standards set forth in the applicable portions of the following recognized standards:

1. AEIC Association of Edison Illuminating Companies.
2. ANSI American National Standards Institute.
3. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers.
4. ASME American Society of Mechanical Engineers.
5. ASPE American Society of Plumbing Engineers.
6. ASSE American Society of Sanitary Engineering.
7. ASTM American Society for Testing and Materials.
8. AWS American Welding Society.
9. CBM Certified Ballast Manufacturers.
10. CDA Copper Development Association.
11. USACE U.S. Army Corps of Engineers.

12. EIA Electronic Industry Association.
13. ETL Electrical Testing Laboratory.
14. FAA Federal Aviation Administration (US Department of Transportation).
15. FCC Federal Communications Commission.
16. FM Factory Mutual Engineering Corporation.
17. FS Federal Specification (General Services Administration).
18. ICEA Insulated Cable Engineers Association.
19. IEEE Institute of Electrical and Electronics Engineers.
20. IES Illuminating Engineering Society of North America.
21. IRI Industrial Risk Insurers.
22. LPI Lighting Protection Institute.
23. MIL Military Standardization Documents (US Dept. of Defense).
24. MSS Manufacturers Standardization Society of the Valve and Fittings Industry.
25. NEC National Electrical Code (by NFPA).
26. NECA National Electrical Contractor Association.
27. NEMA National Electrical Manufacturers Association.
28. NFPA National Fire Protection Association.
29. OSHA Occupational Safety and Health Administration (US Department of Labor).
30. UL Underwriters' Laboratories, Inc.
31. ASSP American Society of Safety Professionals.

1.5 SITE VISIT AND FAMILIARIZATION:

A. General: Become familiar with the Drawings and Specifications, examine the premises, and understand the conditions under which the Contract shall be performed, prior to submitting a bid.

B. Site: Be informed of the site conditions, verify locations of new and existing equipment, and determine exact requirements for connections.

C. Coordination: Submission of a bid for this project infers that the Contractor has visited the site and has become familiar with the Drawings and site conditions and has included in his proposal, all work necessary to properly install the systems on the project.

D. Pre-Bid Conference: Refer to Divisions 0 and 1.

1.6 DRAWINGS AND SPECIFICATIONS:

A. General: The Drawings are schematic in nature and indicate approximate locations of the electrical systems, equipment, fixtures and devices, except where specific locations are noted and dimensioned on the Drawings. All items are shown approximately to scale. The intent is to show how these items shall be integrated into the building. Locate all items by on the job

measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.

B. Location: Prior to locating electrical devices, light fixtures, and other items, obtain the Architect/ Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount lighting fixtures and electrical devices at the heights directed by the Architect/Engineer. Where there is a question concerning the required location for items of electrical work, the Contractor shall submit a request for information to the Architect/Engineer requesting specific directions for locating the item. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.

1. All electrical devices, lighting fixtures, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of building construction details, acoustical tile panels and other building features with respect to the mechanical and electrical outlets and devices. Electrical devices, fixtures, and outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the centers of whole tiles and the exact location of each outlet and the arrangements to be followed shall be acceptable to the Architect/Engineer. Outlets in wall tile or masonry construction shall occur symmetrically in the centers of whole tiles, bricks, or blocks and the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect/Engineer.

2. The Drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the Architectural Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner and Architect/Engineer reserve the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specification are competent to fully explain, may not be mentioned on the Drawings.

D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made to the Engineer.

1.7 DISCREPANCIES:

A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.

B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall submit a request for information to the Engineer for such further Drawings or explanations as may be necessary before proceeding, allowing a

reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. No alleged statement by the Engineer will be accepted as an excuse for inferior work.

D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required by the nature of the project.

1.8 UTILITIES:

A. General: Utility information shown on the Drawings have been shown based upon data obtained from the site survey and the agencies having jurisdiction and are accurate to the best of the knowledge of the Engineer.

B. Coordination: The Contractor shall be responsible for field verification of the actual location of site and/or building utilities and shall make modifications necessary for connection to or construction around those utilities at no additional cost to the Owner or Engineer.

1.9 TEMPORARY FACILITIES:

A. General: Refer to Uniform General Conditions and Divisions 0 and 1 for requirements concerning temporary electrical facilities.

B. Provide power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15, 20, and 30 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

C. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.

D. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate neutral and equipment grounding conductor.

E. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.

F. Provide temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels.

G. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.

H. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

1.10 CHANGE ORDERS:

A. General: Refer to Uniform General Conditions and Divisions 0 and 1 for requirement concerning Change Orders.

1.11 ALTERNATES:

A. General: Refer to Divisions 0 and 1 for information concerning Alternates.

1.12 UNIT PRICES:

A. General: Refer to Divisions 0 and 1 for information on required Unit Prices which are part of the project bid.

1.13 PRECONSTRUCTION CONFERENCE:

A. Conference: Upon the award of this Contract and prior to commencing any work, the Contractor and his designated major subcontractors, shall confer with the Architect, Engineer and Owner concerning the Work under this Contract. The conference shall be at a mutually agreeable place and time.

1.14 SITE OBSERVATION:

A. General: Observation at the site to verify general compliance with Contract Documents shall be made periodically by the Engineer or his representative. Written observation comments shall be submitted to the General Contractor for review and a written response.

1.15 REQUESTS FOR INFORMATION (RFI):

A. General: All Contractor Requests for Information (RFI's) shall be submitted to the Engineer in writing, for response.

B. Format: All RFI's shall be submitted on a form which includes the date, a sequential RFI number, the requested information and space for the Engineer's response, signature and date. RFI’s shall be submitted to the Engineer in a electronic format (unprotected pdf, doc/docx or xls/xlsx format) for response.

C. Responses: The Engineer will endeavor to provide RFI response time in the Engineer's office of five working days after receipt of the RFI by the Engineer.

1.16 SUBMITTALS:

A. General: Submittals required for this project shall include, but not be limited to:

1. Shop Drawings and Product Brochure Submittals.
2. Certifications and Test Reports.
3. Operating and Maintenance Manuals.

4. Warranties (Guarantees).

B. Refer to Division 1 for additional submittal requirements.

C. Shop Drawings and Product Brochure Submittals: The Contractor shall submit one electronic (unprotected pdf format) copy or a sufficient number of complete bound hardcopy sets of Shop Drawings and complete data covering each item of equipment or material. The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment, or actual Shop Drawings. The first submittal of each item requiring a submittal must be received by the Engineer within 90 days of contract award. The Engineer shall not be responsible for any delays or costs incurred due to excessive Shop Drawing review time where the first submittal is received more than 90 days after contract award. The Architect, Owner, and Engineer will each retain one copy of all hardcopy Shop Drawing submittals for their files. The Contractor is required to include a copy of all final electrical Shop Drawing submittals in Electrical O&M manuals.

1. Contractor shall prepare complete submittals that include all pertinent information about the product. A single Shop Drawing shall not contain information from more than one Specification section, but a single Specification section may be subdivided into separate submittals for items or equipment that are specified in that section. Shop Drawings shall be separately bound by complete or partial Specification section. Where a single Shop Drawing contains information from more than one Specification section, it will be marked "REVISE AND RESUBMIT" and returned. Each Shop Drawing shall include the following items enclosed in a suitable binder, Shop Drawings that do not comply with the above requirements will be marked "REVISE AND RESUBMIT" and returned to the Contractor:

   a. A cover sheet with the names and addresses of the Project, Architect, M/E/P Engineer, General Contractor, and the Subcontractor making the submittal. The cover sheet shall also contain the Specification section number applicable to the item or items submitted, the item nomenclature and description and a submittal number. Electrical submittals shall be numbered sequentially by Specification section with a sequence suffix (e.g. 26 22 00-1, 26 23 12-2, 26 25 01-1, etc.). Resubmittals shall be numbered with the original submittal number plus an "R" in the sequence suffix (e.g. the resubmittals of submittal 26 22 00-1 would be 26 22 00-1R1, 26 22 00-1R2, ...).

   b. An index page with a listing of all data included in the submittal.

   c. A list of variations. This page shall list all variations, including unfurnished or additional items or features between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "No Variations". Where variations affect the work of other contractors, then the contractor shall certify on this page that these variations have been fully coordinated with the affected contractors and that all additional costs to the affected contractors associated with the variations shall be paid by the submitting contractor.

   d. Equipment information including manufacturer's name and designation, size, performance and capacity data. All applicable listings, labels, approvals and standards shall be clearly indicated.

e. Dimensional data and actual sketches as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances.

f. Identification of each item of material or equipment matching that indicated on the Drawings.

g. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method. Any non-applicable information shall be crossed out.

h. Additional information as required in other sections of this Division.

i. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Contract Documents, signed and dated.

j. Reports or information requiring certification shall be certified by an authorized officer of the manufacturer or testing agency.

k. Certified Shop Drawings showing dimensions, loading details, anchor bolt locations, and inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.

l. Equipment and material submittals shall show sufficient data including all performance data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances, capacities, materials, and finishes.

D. Required Shop Drawing Submittals: Submit Shop Drawings, including, but not limited to the following items. Refer to individual specification sections for specific submittal requirements.

1.	Basic Materials and Methods	Refer to Section 26 05 01.
2.	Low Voltage Conductors and Cable	Refer to Section 26 05 19.
3.	Electrical Grounding	Refer to Section 26 05 26.
4.	Electrical Raceways	Refer to Section 26 05 33.
5.	Electrical Boxes	Refer to Section 26 05 34.
6.	Electrical Gutters and Wireways	Refer to Section 26 05 35.
7.	Short Circuit Analysis/Coordination Study	Refer to Section 26 05 73.
8.	Low-Voltage Lighting Control	Refer to Section 26 09 26.
9.	Low Voltage Transformers	Refer to Section 26 22 00.
10.	Low Voltage Switchboards	Refer to Section 26 24 13.
11.	Panelboards	Refer to Section 26 24 16.
12.	Electrical Service Entrance	Refer to Section 26 27 01.
13.	Equipment Wiring	Refer to Section 26 27 17.
14.	Miscellaneous Electrical Controls and Control Wiring	Refer to Section 26 27 18.

15.	Voice/Data System Provisions	Refer to Section 26 27 21.
16.	Audio/Visual System Provisions	Refer to Section 26 27 23.
17.	Security System Provisions	Refer to Section 26 27 24.
18.	Wiring Devices	Refer to Section 26 27 26.
19.	Low Voltage Fuses	Refer to Section 26 28 13.
20.	Enclosed Switches	Refer to Section 26 28 18.
21.	Engine Generators	Refer to Section 26 32 13.
22.	Automatic Transfer Switches	Refer to Section 26 36 23.
23.	Lightning Protection for Structures	Refer to Section 26 41 13.
24.	Surge Protective Devices	Refer to Section 26 43 13.
25.	Indoor Lighting	Refer to Section 26 51 00.
26.	Exterior Lighting	Refer to Section 26 56 00.
27.	Addressable Device Fire Alarm System	Refer to Section 28 31 03.
28.	Coordination Drawings	as required by this Section.

E. Samples: Submit two samples, upon request, of electrical devices and materials for review by the Architect/Engineer. Samples will be returned upon written request of the Contractor.

F. Shop Drawing Submittal Review: Shop Drawings will be reviewed for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown in review comments is subject to the requirements of the Contract Documents. The submitting Contractor is responsible for: dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.

1. The Engineer will endeavor to provide a Shop Drawing review time in the Engineer's office of two weeks per review, exclusive of transmittal time, and this review time shall be considered by the Contractor when scheduling his work on the project.

2. The Architect's review or approval and the Engineer's review of Shop Drawings shall not relieve the Contractor of the responsibility for errors, omissions or deviations that may be contained in the submittals. If the Contractor proceeds on the basis of undetected errors, omissions or deviations in reviewed Shop Drawings, it shall be at his sole responsibility and the review does not allow deviations from the requirements of the Contract Documents. Noting some errors, omissions, and deviations but overlooking other errors, omissions, and deviations does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawing or the Engineer's review thereof, the Contract Documents shall govern the Work and are neither waived or superseded by the Shop Drawing review.

3. It shall be the responsibility of the submitting Contractor to check all equipment and materials for conformance with the Contract Documents and "REVIEWED WITH NO EXCEPTIONS TAKEN" or “MAKE CORRECTIONS NOTED” submittal at the time such

equipment and materials are delivered to the job site, and to notify the Engineer of any deviations.

4. Inadequate or incomplete Shop Drawings will not be reviewed by the Architect or the Engineer and will be returned to the Contractor marked "REVISE AND RESUBMIT" for completion and resubmittal.

5. Shop Drawings will be marked "REVIEWED WITH NO EXCEPTIONS TAKEN", "MAKE CORRECTIONS NOTED", " MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE", “REVISE AND RESUBMIT” or "REJECTED" when reviewed by the Engineer. The definitions of these terms for review purposes is as follows:

   a. **REVIEWED WITH NO EXCEPTIONS TAKEN** - The Shop Drawing was reviewed and no exceptions from the general conformance with the design concept and general compliance with the information given in the Contract Documents were noted.

   b. **MAKE CORRECTIONS NOTED** - The Shop Drawing was reviewed and found to have minor deviations from the requirements of the Contract Documents, as noted. A Shop Drawing resubmittal is not required, however, the furnished material/systems shall comply with the corrections noted in the submittal review.

   c. **MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE** - The Shop Drawing was reviewed and found to have either minor deviations from the requirements of the Contract Documents or information missing from the submittal, as noted. A complete Shop Drawing resubmittal is not required, however, a written response to all review comments shall be submitted in the format used for a resubmittal.

   d. **REVISE AND RESUBMIT** - The Shop Drawing was reviewed and major deviations from general conformance with the design concept and general compliance with the information given in the Contract Documents were observed, as noted. The Shop Drawing shall be revised to eliminate the deviations noted and resubmitted.

   e. **REJECTED** - The Shop Drawing was reviewed and is not in general conformance with the design concept or in compliance with the information given in the Contract Documents, as noted. A revised Shop Drawing submittal for the specified equipment or materials shall be resubmitted.

6. Division 1 and General Conditions requirements concerning Shop Drawing submittal review are not applicable to this Division.

7. Materials and equipment which are purchased or installed without a "REVIEWED WITH NO EXCEPTIONS TAKEN" or “MAKE CORRECTIONS NOTED” Shop Drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Architect/Engineer for any reason, shall be at the expense of the Contractor.

8. Shop Drawings shall be complete and checked prior to submission to the Engineer for review. **Where more than three reviews are required for a given Shop Drawing to reach "REVIEWED WITH NO EXCEPTIONS TAKEN" or “MAKE CORRECTIONS NOTED” status, the Subcontractor will be invoiced for extra services at a cost of $100.00 per hour for review of the fourth and subsequent reviews.** If the

Subcontractor fails to pay any legitimate extra services invoice in full within 30 days, then that invoice will be forwarded to the Architect/Owner requesting him to withhold payment of the amount invoiced from the next General Contractors request for payment as allowed for under the General Conditions of the Contract for Construction (AIA Document A-201). Incomplete submittals will be returned to the Contractor unchecked.

G. Certifications and Test Reports: The Engineer may, at their option, witness any or all on and off-site acceptance and operational testing. Submit a detailed listing of certification and testing for each system indicating estimated dates for completion of system installation. This listing of certification and testing shall be submitted at least 30 days before any testing is conducted.

1. Test procedures and test result reporting forms shall be submitted for review no later than the date of the certification and testing listing submittal.
2. Notify the Engineer in writing two weeks prior to all scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.
3. Submit four copies of all certifications and test reports to the Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
4. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section 26 01 25 "Electrical Testing".

H. Operating and Maintenance Manuals: Submit two copies of Operating and Maintenance Manuals to the Engineer for approval prior to the beginning of operator training. Provide four approved Operating and Maintenance Manuals for use in operator training. Manuals shall be bound in rigid cover, 3-ring binders with spine and cover labels and shall provide operating and maintenance information for every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference. Bulletins containing information about equipment which is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of applicable equipment supplied by Division 26, 27 and 28 shall be clearly and legibly set forth in memoranda which shall, likewise, be bound with bulletins. As a minimum, the following information shall be provided as applicable:

1. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams, including sources for all parts.
2. Fully detailed parts lists, including all numbered parts and recommended spare parts, of each item of equipment and apparatus provided under this Division.
3. Manufacturer's printed instructions describing operation, service, maintenance, and repair of each item of equipment and apparatus.
4. Typed record of tests made of materials, equipment, and systems included under this Division. Such records shall state the dates the tests were conducted, name(s) of person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests.

5. Identifying names, name tags designations and locations for all equipment.
6. Fuse and motor heater information including location and use.
7. Equipment and motor nameplate data.
8. Copies of all approved Shop Drawing submittals.
9. Fabrication drawings.
10. Equipment and device bulletins and cutsheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable.
11. Maintenance instructions clearly highlighted to show all required periodic maintenance and lubrication.
12. Wiring diagrams.
13. Operating instructions clearly highlighted to show proper operating procedures for all equipment.
14. Exploded parts views and parts lists for all equipment and devices.
15. Color coding charts for all painted equipment and conduit.
16. Location and listing of all spare parts and special keys and tools furnished to the Owner.

I. Tools: Provide and deliver to the Owner's authorized representative any special tools required for maintenance of systems, equipment, and apparatus installed under this Division prior to requesting final acceptance of the installation.

1.17 PROJECT RECORD DOCUMENTS:

A. Site Prints: Maintain a set of clearly marked prints of the Contract Drawings at the job site which shall be used for recording the work details, final size, location, interrelation, and similar items of all work under this Division. This set of Drawings shall be corrected daily as the Work progresses and shall clearly indicate all changes to suit field conditions, changes made by "Field Order" or "Change Order", accurate dimensions of all buried or concealed work, precise locations of all concealed work, locations of all concealed boxes, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall be to at least two permanent structure points.

B. Upon completion of the work, the Contractor shall clearly and legibly transfer all marks from the site prints to a set of reproducible Record "As-Built" Drawings using red pen or pencil. The reproducible Record "As-Built" Drawings shall have the Engineers Name and Seal removed or blacked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS

DATE: _____

_____
(NAME OF GENERAL CONTRACTOR)

_____
BY: (SIGNATURE)

_____
(NAME OF SUBCONTRACTOR)

_____

BY: (SIGNATURE)

C. Approval: Prior to final acceptance of the Work of this Division, the Contractor shall submit three prints of properly certified Record Drawings to the Engineer for review and shall make changes, corrections or additions as the Engineer may require to the Record Drawings.

1.18 COORDINATION OF ELECTRICAL WORK:

A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details.

1. Arrange electrical work in a neat, well organized and workmanlike manner with services running parallel with primary lines of the building construction and with a minimum of 7’ overhead clearance where possible.

2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.

3. All conduit and boxes except those in the various equipment rooms, in unfinished spaces or where specifically designated herein or on the Drawings shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in equipment placement, etc.

4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor.

5. System interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:

   a. Building lines.

   b. Structural members.

   c. Soil and drain piping.

d. Steam and condensate piping.

e. Sprinkler piping.

f. Vent piping.

g. Supply ductwork.

h. Exhaust ductwork.

i. Chilled water and heating hot water piping.

j. Domestic water piping.

k. Electrical conduit.

6. Locate electrical equipment properly to provide easy access. Arrange entire electrical work with adequate code access for operation and maintenance.

7. Advise other trades of openings required in their work for the subsequent move in of large units of electrical work (equipment).

8. Coordinate all items which will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical connections, space requirements, sequence of construction, building requirements and special conditions.

9. When submitting Shop Drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

B. Coordination Drawings:

1. Coordinate the work of all Subcontractors for this Division with the Contractors and Subcontractors responsible for this and other Divisions. Provide, in writing (with copies to the Engineer, Architect and Owner) all information necessary for coordination to permit the work of the project, including all Divisions, to be installed satisfactorily and with the least possible interference or delay.

2. This Divisions Contractors, in coordination with Contractors responsible for other Divisions, shall prepare a complete set of construction "Coordination Drawings" which shall be completed and submitted to the Engineer, Architect and Owner within one (1) months after notice to proceed is given to the General Contractor. If the General Contractor or any Subcontractor allows any work to be installed before coordinating with the work of other Subcontractors, the necessary changes for field coordination shall be made without extra cost to the Owner, Architect or Engineer.

3. "Coordination Drawings" shall be drawn at a scale of not less than 1/4" = 1'0" and shall be originals or CAD plots, Drawings shall show actual equipment being provided and shall maintain all design drawing space allocations, designated dimensions, ceiling heights, chase dimensions, room sizes and required service clearances for the actual equipment being provided. Deviations from ceiling heights, chase dimensions, room sizes and similar requirements to the Construction Documents shall not be made without specific prior written authorization from the Architect.

4. "Coordination Drawings" for interior construction shall show the coordinated locations for equipment, ductwork, piping, conduit, busway, devices, etc. and shall show all ductwork, all busway and all pipe and conduit larger than 4" using double lines. Elevations shall be shown for all construction and horizontal dimensions from major construction to accessible column or building lines shall be shown. Where required for coordination, offsets shall be shown and sections shall be cut and drawn.

5. "Coordination Drawings" shall indicate loads and anchor/support points for all piping 8" and larger, for all racked piping, for all racked conduit 3" and larger, for all busway and for all suspended equipment. These drawings shall be submitted to the Structural Engineer for review and approval. Any special hangers, embeds, supports, reinforcing, etc. required by the Structural Engineer shall be provided at no additional cost to the Owner.

6. "Coordination Drawings" for all work routed underground or embedded in concrete shall show specific dimensions to accessible column or building lines and the burial depth of all underground utilities. Where existing utilities are located in the area where new utilities are being installed, dimensions and burial depth for existing utilities shall be shown on "Coordination Drawings".

7. Prior to submittal, each "Coordination Drawing" shall be completed and signed off by the General Contractor and all applicable Subcontractors prior to the submission to the Architect, Engineer and Owner and prior to installation of Division 21, 22, 23, 25, 26, 27 and 28 work in the area covered by the specific coordination drawing.

8. The requirement for "Coordination Drawings" shall not be construed as releasing the General Contractor or Subcontractors from their responsibility to coordinate the installation of the work or as authorization for the General Contractor or Subcontractors to make unauthorized changes to the Construction Documents or the project design concepts.

1.19 MATERIALS AND WORKMANSHIP:

A. General: Materials and equipment shall be new, of best grade and quality, and standard products of reputable manufacturers regularly engaged in the production of such materials and equipment.

B. Workmanship: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.

C. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

1.20 SPACE REQUIREMENTS:

A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate code clearances for adjustments, repair, or replacement.

B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.

C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.

D. Responsibility: Since space requirements and equipment arrangement vary for each manufacturer, the responsibility for initial access and proper fit rests with the Contractor.

E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

1.21 SAFETY REGULATIONS:

A. All electrical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the electrical work shall be provided by and operated by the Electrical contractor.

1.22 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.

B. Scope: Work under this Division shall include, but not limited to:

1. Shipping from point of manufacture to job site.
2. Unloading, moving, and storage on site with proper protection as required to properly protect equipment from rust, drip, humidity, dust, or physical damage.
3. Hoisting and scaffolding of materials and equipment included in this Division.
4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

C. Coordination: All large pieces of apparatus which are to be installed in the building and which are too large to permit access through doorways, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed. All apparatus shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering where required for protection.

1.23 NOISE AND VIBRATION:

A. General: Warrant the electrical systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.

1.24 CLEANING, ADJUSTING AND START-UP:

A. Start-up Services: Where specified for any individual item of electrical equipment, provide a factory-authorized representative for testing, start-up of equipment, and instruction of

Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

B. Testing: Refer to Section 26 01 25, “Electrical Testing” for requirements.

C. Clean-up: Each Contractor shall clean away from the job site all debris, surplus material, and similar items, resulting from his work or operations, leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, conduit, boxes, fixtures, and similar items, leaving the installation in a first class condition.

D. Operation Prior to Completion: When any piece of electrical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Engineer's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of final acceptance and the start of the warranty may not be the same date.

1.25 FINAL REVIEW:

A. General: Upon completion of the Work, perform a final test of the entire system.

1. The system shall be operating properly.

2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications or the Drawings, shall be accomplished without delay in order to secure final acceptance of the Work.

3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the time allotted for completion of the Contract. Retests shall be conducted as directed and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.

4. Certificates, including certificates of occupancy from local authorities and documents required herein, shall be completely in order and presented to the Engineer at least one week prior to the review.

B. Qualified Person: Individuals knowledgeable of the systems and persons approved by the Engineer, shall be present at this final inspection to demonstrate the system and prove the performance of the equipment.

1.26 OWNER INSTRUCTION:

A. General: This Contractor and appropriate factory-trained representatives shall instruct the Owner's representative in the proper operation and maintenance of all systems and equipment and shall explain all warranties.

B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.

C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.

D. Other Requirements: Refer to other Division 26, 27 and 28 Sections for additional Operator Training requirements.

1.27 CONTRACTOR WARRANTIES AND GUARANTEES:

A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 12 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.

B. Equipment: All equipment bearing a manufacturer's guarantee, such as electrical equipment, devices, components, and similar items, shall be construed to have an extended guarantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.

C. Start-up: The Electrical Contractor shall provide instructions and equipment starting service on new equipment for one complete year after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION 26 00 01

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 26 05 01 - ELECTRICAL BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide basic materials and methods for electrical construction as shown, scheduled, indicated, and specified.

B. Types: The types of basic materials and methods required for the project include, but are not limited to:

1. Manner of running conduits.
2. Hangers and supports.
3. Attachment.
4. Sleeves.
5. Openings, cutting, and patching.
6. Excavation, trenching, and backfilling.
7. Access doors.
8. Firestopping for conduit, busway, wire, and cable.
9. Fire-rated partitions.
10. Flame spread properties of materials.
11. Penetration flashing and seals.
12. Escutcheon plates.
13. Cleaning and painting of electrical work.
14. Prohibited markings.
15. Tamper resistant fasteners.
16. Equipment housekeeping pads and anchor bolts.
17. Concrete.
18. Wiring device and equipment mounting heights.

1.3 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Engineer for review, a list of proposed manufacturers and product data on hangers, supports, and methods of attachment to the structure.
2. Excavation and trenching plan, designed and sealed by a registered professional engineer. Refer to Division 1 for additional submittal requirements.
3. Cut sheets on access doors and fire stopping materials products.
4. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver components in factory-fabricated water resistant packaging.

B. Handle components carefully to avoid damage to components, enclosures, and finish.

C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General: Refer to PART 3 - EXECUTION of this Section and other Division 26 sections for basic electrical products and materials.

PART 3 - EXECUTION

3.1 MANNER OF RUNNING CONDUITS:

A. All conduits shall be concealed in pipe chases, walls, furred spaces, topping, or above the ceilings of the building unless otherwise indicated.

B. Conduit may be run exposed in mechanical rooms, duct and piping chases, but only where necessary. All exposed conduit shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.

C. All conduit and surface raceways shall be adequately and properly supported from the building structure by means recommended by the manufacturer, or by the use of hanger rods or clamps as herein specified.

D. Where limited space is available above the ceilings and below concrete beams or other deep projections, conduit shall be sleeved through the projection where it crosses rather than hung below them and in a manner to provide maximum above-floor clearance.

E. No sleeves shall be installed through any concrete beam or other deep projection without written approval of the Architect/Engineer.

F. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8" clear.

G. Whenever possible, install horizontal conduit runs above water piping.

H. Install all conduit to allow for adequate maintenance and access clearances to all equipment and so as to not inhibit removal of ceiling tiles.

I. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Construction Inspector and resolve the conflict prior to erection of any work in the area involved.

J. Conduit and raceway connections, rough-in and stub-up locations for equipment shall be coordinated by the Contractor to provide locations indicated on approved manufacturers equipment shop drawings. Connection, rough-in and stub-up locations shown on the Drawings are diagrammatic for general reference only.

3.2 HANGERS AND SUPPORTS:

A. All supports required for the proper installation of equipment, cable tray, wireway, and conduit shall be provided as hereinafter specified unless otherwise indicated on the Drawings.

B. All conduits throughout the building shall be supported as specified in Section 26 05 33, “Electrical Raceways”, unless specifically noted differently on the Drawings or in the Specifications, but in every case shall be adequate to support the raceway being suspended. The supports shall be from the structure to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage.

C. Vertical conduits shall be supported from floor lines with riser clamps sized to fit the conduit and to adequately support their weight, with allowance for expansion and contraction. At the bases of conduit, where required for proper support, provide anchor base fittings or other approved supports.

D. Perforated strap shall **not** be used as a hanger material. Conduit **shall not** be supported from ductwork, piping, or equipment.

E. All electrical conduits and surface raceways exposed to view shall be run parallel to the adjacent building construction. All hangers shall be fastened to the building structure in a manner as hereinafter specified under "Attachment".

F. Single conduits running horizontally shall be supported by Caddy, Minerallac, or approved equal adjustable conduit hangers from adequately sized rods (minimum 1/8") from the building structure. Refer to Section 26 05 33 for additional requirements.

G. Multiple conduits running horizontally shall be supported by trapeze channels suspended on rods or bolted to vertical building members. Channels shall be as manufactured by Unistrut, Superstrut, Powerstrut, Kindorf, Elcen, T&B or approved equal. Conduits shall be secured to the channel with galvanized or stainless steel clamps. Refer to Section 26 05 33 for additional requirements.

H. Vertical conduits, both concealed and exposed, shall be supported by clamping to vertical surfaces or by means of clamps resting on adjacent beams, or floor slabs, or both as required by the installation. Refer to Section 26 05 33 for additional requirements.

I. Conduits and raceways run against building surfaces shall be supported by means recommended by the manufacturer, or by means of single or two hole rigid conduit clamps. Two-hole clamps shall be provided where size of conduit and installation conditions warrant. Refer to Section 26 05 33 for additional requirements.

J. All auxiliary steel required for conduit, cable tray, and wireway supports, etc. shall be provided by this Division unless specifically indicated to be provided by others. All indoor

support steel and fasteners shall be galvanized and all outdoor support steel and fasteners shall be hot-dip galvanized.

K. Contractor shall review all Drawings, including Structural Drawings, for details regarding supports.

L. All supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

3.3 ATTACHMENT:

A. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

B. All conduits not embedded in concrete or masonry shall be securely and independently supported so that no strain will be transmitted to outlet box and pull box supports, etc. Supports shall be rigid enough to prevent distortion of conduits during wire pulling.

C. Inserts shall be of a type which will not interfere with reinforcing, as indicated on the Structural Drawings, and which will not displace excessive amounts of structural concrete. All methods of attachment to the structure and the use of afterset inserts shall be approved in writing by the Structural Engineer.

D. All conduit supports shall be designed and installed to avoid interference with other piping, hangers, ducts, conduit, supports, building structures, equipment, etc. All conduit, cable tray, and wireway shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

E. Hangers shall be attached to structure as follows:

1. Poured-in-place Concrete:

a. Where conduits, equipment, etc., are supported under poured-in-place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which shall be set into a UL-listed universal concrete insert placed in the form work before concrete is poured.

b. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly, or where a larger insert would require displacement of a bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc., spanning across to adjacent joists. The angle iron shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

2. Steel Bar Joists:

a. Where light loads are supported under bar joists, hanger rods may be run with a washer and two nuts.

b. Where larger loads are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

3. Steel Beams: Where loads are supported under steel beams, approved type beam clamps shall be used.

4. Wood Framing: Where loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.

5. Miscellaneous Steel: All miscellaneous steel members, angles, rods, supports, and similar items specified or required for this project shall be galvanized for indoor use or hot dipped galvanized for exterior use and where exposed to ambient conditions. All required miscellaneous steel shall be provided by this Division.

F. Fastening of conduits, etc., in the building shall be as follows: To wood members - by wood screws; to masonry by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. Power-actuated fasteners (shooting) will not be acceptable for attaching conduit clamps, boxes and hanger wire unless approved by the Architect/Engineer in writing.

3.4 SLEEVES:

A. Provide sleeves for timely placing in construction for all conduit passing through concrete and masonry walls, partitions, beams, floors and roofs while same is under construction.

B. In general, a conduit sleeve shall be one size larger than the size conduit which it serves, except where larger sizes are required for manufactured water stop fittings.

C. No sleeves shall be installed through any concrete beam or other deep projection without written approval of the Architect/Engineer.

D. Sleeves set in concrete floor construction shall be minimum 18 gauge, galvanized steel, and shall extend 2" above the finished floor. Where sleeve will be used to support a conduit riser clamp, sleeve gauge shall be increased accordingly.

E. Sleeves for concrete or masonry walls shall be Schedule 40, galvanized steel, and shall be set flush with the finished wall.

F. Sleeves for conduits passing through walls below grade shall be wall sleeves with corresponding segmented annular seals for the conduit size required as specified in Paragraph 3.11.

G. Where sleeves are not properly set during construction and must be installed by cutting and patching, obtain direction from the Architect/Engineer prior to proceeding.

H. Sleeves are not required where new openings are core-drilled into existing construction, unless noted otherwise on the Drawings.

3.5 OPENINGS, CUTTING AND PATCHING:

A. General: The Contractor shall be responsible for coordinating openings in the building construction for installation of electrical systems. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of electrical work. Except as individually authorized by the Architect/Engineer, cutting and patching of electrical work to accommodate the installation of other work is not permitted.

B. Cut and Patch: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

C. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.

D. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from the Architect/Engineer. Patching shall create a surface which is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.

E. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

F. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes. Restoration work shall be performed by the trades who originally installed the work being restored and shall be performed at no cost to the Owner or Architect/Engineer.

G. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

H. Plaster: All electrical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

I. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.6 EXCAVATING, TRENCHING AND BACKFILLING:

A. General: The work hereunder includes whatever excavating and backfilling is necessary to install the electrical work. Coordinate the electrical work with other work in the same area, including excavating and backfilling, dewatering, floor protection provisions, other temporary facilities, other underground services (existing and new), landscape development, paving, structural foundations, and floor slabs on grade. Coordinate with weather conditions and provide temporary facilities needed for protection and proper performance of excavating and backfilling.

B. Standards: Except as otherwise indicated, comply with the applicable provisions of Division 2 for electrical work excavating and backfilling. Refer instances of uncertain applicability to the Architect/ Engineer for resolution before proceeding with the Work.

C. The bottoms of trenches shall be excavated to required depths, slope and grade. The bottom of the trench shall be accurately excavated to provide firm, uniform bearing for the bottom of the raceways and ductbanks. Where mud or unstable soil is encountered in bottom of trench, it shall be removed to firm bearing and the trench shall be backfilled with bedding sand to proper grade and tamped to provide uniform firm support.

D. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the conduit on undisturbed soil or 2" of sand fill at every point along its entire length. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole.

E. Exercise care not to excavate below required depth, leaving a flat bed of undisturbed earth, firm and secure, before laying cable, and ductbanks. In the event rock is encountered, excavate 6" below required depth and backfill to required depth with bedding sand, and compact to minimum 95% compaction.

F. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the site and properly disposed of.

G. The Contractor shall be fully responsible for the safety of persons, materials and equipment in or near trenches or other excavations and provide all required sloping, shoring, railings and other protective provisions. The Contractor shall provide a trench shoring plan and design which is sealed by a registered professional engineer. Refer to Divisions 1 and 2 for additional requirements.

H. If any unknown and/or uncharted utilities are encountered during excavation, promptly notify Architect/ Engineer and wait for his instructions before proceeding.

I. If such unknown utilities are encountered and work is continued without contacting the Architect/ Engineer for instructions, and damage is caused to said utilities, the Contractor shall repair at his own expense, such damage to the satisfaction of the owner or utility company concerned.

J. Trenches shall not be backfilled until all required tests have been made by the Contractor and approved by the Architect/Engineer and any local authorities having jurisdiction.

K. Backfill shall be compacted or cement stabilized sand up to 6" above the top of conduit or ductbank. Backfill up to grade shall be in maximum 6" lifts with minimum 95% compaction of lifts. Refer to Division 2 or elsewhere in Contract Documents for additional trenching and backfill requirements.

L. Opening and Reclosing Pavement, Landscape Areas and Lawns: Where excavation requires the opening of existing walks, street, drives, other existing pavement or lawns, such surfaces shall be cut as required to install new conduit and to make new connections to existing conduits. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched or replaced, using materials to match those cut out or removed. Patches shall thoroughly bond with the original surfaces, shall be level with them, and shall meet all the requirements established by the authorities having

jurisdiction over such areas. All removed work shall be replaced by craftsman who regularly install the types of work being replaced.

M. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5' to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Architect before they are cut or damaged in any way. The Architect will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

3.7 ACCESS DOORS:

A. General: This Contractor shall provide wall or ceiling access doors for installation in finished surfaces for unrestricted access to all concealed items of electrical equipment.

B. Types: Doors shall be factory-finished as noted below and turned over to the General Contractor for installation. Refer to finish painting requirements specified herein below. Doors shall be as manufactured by Inryco/Milcor or an approved equal in the following styles:

1.	Drywall Construction	Inryco/Milcor Style DW with gray prime finish.
2.	Finished Acoustical Ceiling Tile	Inryco/Milcor Style AT with door designed for tile insert.
3.	Finished Plaster Ceiling or Walls	Inryco/Milcor Style AP with door designed for finish plastering.
4.	Masonry Walls	Inryco/Milcor Style M with gray prime finish.
5.	Fire Rated Construction	Inryco/Milcor Fire Rated Access Door with gray prime finish.
6.	Fire Rated Ceiling or Ceiling Assembly	Inryco/Milcor Style ATR with door designed for tile insert.

C. Selection: Access doors shall be furnished with a continuous piano hinge with screwdriver-operated flush locks and shall be a minimum of 12" x 12". Larger sizes shall be furnished where required for proper access. Access doors shall not be installed until location and style has been approved by the Architect.

D. Approval: Access door shall not be installed until location and style have been approved by the Architect.

3.8 FIRESTOPPING FOR CONDUIT, BUSWAY, WIRE AND CABLE:

A. General: Provide a UL Systems Classified, intumescent material capable of expanding up to three to five times when exposed to temperatures beginning at 250°F for sealing all holes or voids created to extend electrical system conduit, raceways, busway, wire, cable and other components through fire-rated floors and walls to prevent the spread of smoke, fire, toxic gas and water.

B. Fire barrier products shall be used to create through-penetration firestop systems as required. All firestop systems shall be listed in the Underwriter's Laboratories Building Materials Directory, Through Penetration Firestop Systems (XHEZ).

C. The products manufactured by 3M/Electrical Products Division or an approved equal are acceptable subject to Shop Drawing submittal approval.

D. Install firestop materials according to the following UL Systems Classifications and manufacturer's recommendations:

OPENING TYPE	UL SYSTEM CLASSIFICATION NUMBER
Metal Conduit/Metal Pipe Through Round Openings	CAJ1001, CAJ7001, CAJ1007, WL1001, WL1002, WL1003, WL5001, WL5002.
Busway Through Rectangular Openings	CAJ6001
Insulated Power Cables/Telephone Cables Through Openings.	CAJ3001, CAJ1001, CAJ7001, WL3001.
Blank Openings/Joints/Expansion Trenches	CAJ0004, CAJ0001.
Cable Tray (Single or Double)	CAJ4003.
Metal Pipe/Conduit/Cables Through Large Openings	CAJ1006, CAJ3005, CAJ8001.
Plastic Pipe/Plastic Conduit Through Openings	CAJ2001, CAJ2002, CAJ2003, CAJ2004, CAJ2005, FA2001, WL2002, WL2003, WL2004, WL2005.
All Other Firestop Systems	Per manufacturer's recommendations.

E. Provide fire rated insulation blankets around conduits where shown on Drawings. Blankets shall be one inch (1"), 8 pound density thermo ceramic material, Thermo Ceramics Kas-Wool Fire Master Series thermal blankets or and approved equal. Blankets shall be wrapped to provide continuous coverage and be secured with stainless steel bands in accordance with the manufacturer's UL-listed installation instructions.

3.9 FIRE-RATED PARTITIONS:

A. Coordinate locations of raceways in fire-rated partitions so not to effect the fire rating of the partition. Notify the Architect/Engineer in writing where additional construction is required to maintain the partition fire rating.

B. Outlet boxes installed in fire-rated partitions (2 hour or less) shall not exceed 16 square inches, with a maximum of 100 square inches of wall opening per 100 square feet of wall area.

C. The outlet boxes shall be located whereby no two outlet boxes are installed closer than 24" on center, and securely attached to the partition studs, with at least one partition stud separating the outlet boxes.

3.10 FLAMESPREAD PROPERTIES OF MATERIALS:

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255 (1984), "Method of Test of Surface Burning Characteristics of Building Materials". The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke-developed rating of 50.

3.11 PENETRATION FLASHING AND SEALS:

A. Conduit sleeves, pitch pockets, and flashings compatible with the roofing and waterproofing installation shall be provided for all roof and wall penetrations and roof-mounted equipment and supports. Coordinate flashing details with the Architectural details and the roofing/waterproofing contractors.

B. Conduits passing through walls where exposed to weather or below grade shall pass through waterstop sleeves (new construction) or core-drilled openings (existing construction). The space between the conduit and sleeve/opening shall be sealed using segmented annular seals to prevent the entry of water or foreign materials. Segmented annular seals shall be Thunderline Incorporated, Type LS Series, Style C insulating type link seals for temperatures up to 250°F, or an approved equal. Waterstop sleeves shall be Thunderline Corporation Century-Line or equal noncorroding thermoplastic sleeves with a molded in water stop lip.

3.12 ESCUTCHEON PLATES:

A. Except as otherwise noted, provide chrome-plated brass floor and ceiling escutcheon plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any finished spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for conduit where pipe sleeves extend above finished floor. All equipment rooms are classified as finished spaces.

3.13 PROHIBITED MARKINGS:

A. Prohibited Markings: Markings which are intended to identify the manufacturer, vendor, or other source from which the material has been obtained are prohibited for installation within public, tenant, or common areas within the project. Also prohibited are materials or devices which bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters' Laboratories, Inc.), and approval labels are exceptions to this requirement.

3.14 EQUIPMENT HOUSEKEEPING PADS AND ANCHOR BOLTS:

A. Concrete pads for equipment (Housekeeping Pads) will be furnished under this Division. Pads shall be provided in locations where floor mounted equipment is to be installed.

B. Pads shall be nominal 3-1/2" high and shall extend a minimum of 3" beyond all equipment and supports while generally conforming to the shape of the equipment.

C. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 - 6" x 6" welded wire mesh. Pad tops and sides shall be hard troweled smooth with a 3/4" bull nose on all external corners. Refer to Division 3 for additional requirements.

D. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.

3.15 CONCRETE:

A. All concrete used in light pole bases and ductbank encasement shall be 5 sack mix with 1/2" maximum aggregate and 3000 psi compressive strength when tested after 28 days in accordance with ASTM C39/C39M-18, "Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens". Refer to other Divisions for additional requirements.

B. Add Solomon Colors Iron Oxide Pigment in color 290 Red or and approved equal dye per cubic yard of wet mix ductbank encasement concrete to form a uniform red color throughout the concrete. The amount of pigment required shall be as recommended by the manufacturer.

C. Use forms except where the earth is firm enough to support the concrete. Above grade portions of pole bases shall be formed using Sonatube or an approved equal forming system.

D. Keep concrete wet at least 48 hours after forms are removed to ensure proper curing.

E. Ductbanks and light pole bases shall be reinforced where noted on the Drawings. Refer to Division 3 for reinforcing steel.

F. Ductbank concrete shall be carefully spaded during the pouring to eliminate all voids under and between the ducts and to prevent honeycombing of the exterior surfaces. Power driven tampers or agitators shall not be used unless specifically designed for the application.

G. Generally, each run of the ductbank shall be poured in one continuous operation. Where more than one pour is necessary, each pour shall terminate in an angular plane, and reinforcing rod dowels shall be added as necessary to ensure a sound joint. Partial pours shall not terminate in horizontal or vertical planes.

H. The concrete encasement covering the ductbank may be poured directly against the sides of the trenches if the cut is clean enough, and free of loose material. All loose dirt and extraneous material shall be removed from the trenches before and during the pouring of the concrete to ensure sound envelopes. The trench bed shall be smooth and properly graded for the placement of the bottom row of spacers.

3.16 WIRING DEVICE AND EQUIPMENT MOUNTING HEIGHTS:

A. Refer to architectural drawings to determine whether outlets occur in wainscot or cabinet spaces and coordinate mounting heights as required by architectural form. For example, mounting heights of outlets occurring in a tile or brick wall should be adjusted so that the outlet will occur entirely within a single course. However, all outlets in a given space shall be mounted at the same height.

B. In general, unless noted otherwise on Architectural or Electrical Drawings, mounting heights to device center line shall be as follows**:**

1.	Wall Switches	45" above finished floor.
2.	Receptacles	18" above finished floor.
3.	Receptacles	6" above countertops without splash backs and 4"above splash backs for countertops with splash backs, mounted with their long axis horizontal.
4.	Clock Outlets	7'-6" above finished floor.
5.	Panelboards	72" from finish floor to top of panelboard.

6.	Stairway Lighting Fixtures	Wall mounted 7'-6" above finished floor or mid-landing.
7.	Fire Alarm Pull Stations	Coordinate with architectural graphics package for actual mounting heights.
8.	Fire Alarm Wall-Mounted	6'8" above finish floor or 6" below ceiling, Audio/Visual Signals whichever is lower.

C. All receptacles shall be mounted with their long axis vertical, unless noted otherwise.

END OF SECTION 26 05 01

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SECTION 26 05 19 - LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide low voltage electrical conductor, cable, wire, and connector work as shown, scheduled, indicated, and as specified.

B. Types: The types of low voltage electrical conductor, cables, wire, and connectors required for the project include, but are not limited to, the following:

1. 600 volt building wire and cable.
2. 600 volt building wire and cable connectors.
3. 300 volt control/signal wire and cable.
4. 300 volt control/signal wire and cable connectors.

C. Application: The applications for cable, wire, and connectors required on the project are as follows:

1. Power distribution circuitry.
2. Lighting branch circuitry.
3. Appliance, receptacle and equipment branch circuitry.
4. Motor branch circuitry.
5. Control wiring.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. ANSI/ICEA S-95-658/NEMA WC70 – Nonshielded 0-2kV Cables
2. ASTM B3-13(2018) - Standard for Specification for Soft or Annealed Copper Wire.

B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/ Engineer.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. 600 Volt Building Wire and Cable:

a. Cerro Wire and Cable Company.
b. Colonial Wire and Cable.
c. Encore Wire Corporation.
d. General Cable Corporation.
e. Okonite Company.
f. Republic Wire Inc.
g. Southwire Company.

2. Type MC Cable:
   a. AFC.
   b. Southwire.
   c. United Copper Industries.
3. 300 Volt Wire and Cable:
   a. Alpha Wire.
   b. Belden.
   c. West Penn Wire.
4. Connectors:
   a. TE Connectivity/AMP Connectors
   b. Buchanan.
   c. Burndy Corporation.
   d. OZ-Gedney - Emerson.
   e. General Electric Company.
   f. Ideal Industries, Inc.
   g. Mac Products, Inc.
   h. Minnesota Mining and Manufacturing Company (3M).
   i. Penn-Union.
   j. Orbit Industries, Inc.
   k. Thomas & Betts Company.

B. UL Label: All cable, wire, and connectors shall be UL-labeled.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of wire and cable, cable lugs, cable connectors and termination fittings

listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets on all 300 and 600 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.

3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.

4. Cut sheets indicating types of conductor identification bands.

5. Additional information as required in Section 26 00 01, “Electrical General Provisions”..

1.6 DELIVERY, STORAGE AND HANDLING:

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire, or connectors shall be removed from project site.

B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - PRODUCTS

2.1 600 VOLT BUILDING CABLE, WIRE AND CONNECTORS:

A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.

B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be No. 12 copper (No. 14 for light fixture pigtails) with insulation as noted below. Minimum size for control wiring shall be No. 14 copper.

C. Conductors: Provide soft or annealed copper wires meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.

1. Conductors for power wiring sized No. 10 AWG and smaller shall be stranded or solid at the Contractors option, except that solid conductors shall be provided where conductors are terminated under terminal screws and stranded conductors shall be provided for connections to vibrating or movable equipment. Stranded conductors may be terminated on back wired wiring devices where wiring is mechanically secured via a side screw. Conductors for control wiring sized No. 10 AWG and smaller shall be stranded, except that solid conductors or stranded conductors with UL Listed crimp on connectors shall be provided where conductors are terminated under terminal screws.

2. Conductors sized No. 8 AWG and larger shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B8, "Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft".

D. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires".

1. Insulation for conductors sized No. 10 AWG and smaller shall be UL Type "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
2. Insulation for conductors sized No. 8 AWG and larger shall be UL Type "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
3. All wiring inside lighting fixtures shall be temperature rated per the NEC.
4. Branch circuit wiring within 3" of fluorescent ballasts shall be temperature rated for 90°C.

E. Connectors for Building Wire and Cable: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for each use.

2.2 TYPE MC CABLE:

A. Metal-clad Type MC Cable: At the Contractor's option, and subject to the approval of the local electrical inspection department and where allowed in the NEC, Type MC cable may be used for receptacle circuits, switch legs, and lighting fixture connections to the junction box grid system in finished areas. Type MC cable shall consist of two No. 12 AWG copper THHN insulated phase conductors and one No. 12 AWG green THHN insulated copper ground conductor, all enclosed in cable tape and an aluminum or galvanized steel flexible armor. Type MC cable terminations shall be made using approved anti-short fittings. **Refer to NEC 517 where use is approved by the NEC for emergency wiring.**

2.3 300 VOLT CONTROL/SIGNAL CABLE, WIRE AND CONNECTORS:

A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.

B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each use.

C. Conductors: Provide soft or annealed copper wires as individual conductors, twisted together or shielded, where required, and meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.

D. Conductor Gauge: Provide conductor gauge as required for the application with a minimum of 24 AWG. Conductors shall be stranded or solid as required by the application or manufacturer.

E. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Thermoplastic-Insulated Wires and Cable", and the requirements of NEC Article 725 for Class 2 wiring.

1. Insulation shall be rated for a maximum working voltage of 300 volts; PVC jacket; UL-listed.
2. Insulation of cables used in environmental air spaces shall be nonmetallic jacket UL-listed for use in air plenums.

F. Connectors: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for the application.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Coordination:

1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. 600 Volt Building Wire and Cable:

1. Mains and feeders are to be run their entire length in continuous pieces without joints or splices.
2. Conductors may be run in multiple on sizes No. 1/0 AWG through 600 kcmil inclusive, provided all multiple conductors are the same size, length, and type of insulation, and are so arranged and terminated as to ensure equal division of the total current between all conductors involved.
3. Before any wire is pulled into any conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit. All conductors shall be pulled into the conduit at the same time.
4. Cables shall be selected on the basis of their purpose and UL-listing. Generally, use Types "THWN" and "THHN" in building interiors and other dry locations. Outdoors and underground in raceways, use Type "THWN". Conductors subject to abrasion, such as in lighting poles, shall be Type "THWN" or "THHN".
5. Feeder conductors shall be sized such that the voltage drop from the source to the load served shall not exceed 2% at maximum load and 80% power factor, at 120/208 volts and 1% at maximum load and 80% power factor at 277/480 volts.
6. Where pulling lubricant is required, use only non-wax based cable lubricants equal to American Polywater as a lubricant. Wire pulling lubricant shall not be used when installing branch circuit conductors from panelboards with "isolation" transformers.
7. Pull all conductors together when more than one conductor is being installed in a raceway. Where more than six power conductors are installed in a single conduit, a conductor derating factor per NEC Table 310-15(B)(2)(a) shall be applied to conductor ampacity.

8. The use of shared branch circuit neutrals is not permitted. Separate neutral conductors shall be pulled for all branch circuits served by single pole and where required for 2 and 3 pole circuit breakers.
9. No conductor smaller than No. 12 AWG shall be used for power or lighting purposes (except light fixture tails). Switch legs shall be No. 12 AWG. Control circuit wiring may be No. 14 AWG minimum, and shall not be run in same conduit with power wiring.
10. Lighting and power branch circuit conductors shall be sized such that the voltage drop from the panelboards to the farthest point on the circuits shall not exceed 2% at maximum load and 80% power factor, at 120/208 volts and 1% at maximum load and 80% power factor at 277/480 volts.
11. For 120 volt, 20 amp branch circuits with a length of 75' or more to the homerun junction box or first outlet, provide minimum No. 10 AWG conductors to the homerun junction box or first outlet. Where the additional circuit length from the homerun junction box or first outlet to the last outlet exceeds 75', provide minimum No. 10 AWG conductors to the last outlet.
12. For 208 volt, 20 amp branch circuits with a length of 100' or more, provide minimum No. 10 AWG conductors for the entire branch circuit.
13. For 208 volt, 30 amp branch circuits with a length of 100' or more, provide minimum No. 8 AWG conductors for the entire branch circuit.
14. For 277 volt, 20 amp branch circuits with a length of 150' or more, to the first outlet provide minimum No. 10 AWG conductors to the center of the load (minimum first outlet, where there is only one outlet).
15. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.
16. Conductors for connection to individual light fixtures in grid type ceilings from their associated junction boxes, shall be 3 No. 14 AWG THHN copper 600 volt, solid conductors in 72" long 3/8" flexible metal conduit fixture-tails, or by Type MC cable fixture tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8'.
17. All conductors in vertical conduits or raceways shall be supported in the manner set forth in the latest edition of the National Electrical Code.
18. 2 hour rated cables shall be installed in conduit and supported per UL to provide a 2 hour installed rating.
19. Do not use a pulling means, including fish tape, cable, or rope which can damage the raceway.
20. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
21. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.
22. All wire on this project shall be new, unused, in good condition, and shall be delivered in standard coils, package, or rolls. Samples of all wire shall be submitted by the

Contractor when requested by the Engineer for the purpose of determining acceptability of the wire.

23. Wire which has been rejected by the Engineer shall not be used again. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner's duly authorized representative.
24. Do not permit conductors entering or leaving a junction or pull box to deflect so as to cause pressure on the conductor insulation.
25. Splices and taps on branch circuits shall occur only when such circuits divide as shown on the drawings and shall consist of one "through" circuit to which the circuit shall be spliced or tapped. Through wiring of receptacles and other devices is not allowed, except for GFI devices noted on the drawings to protect downstream devices.
26. Connections to devices (receptacles, switches, etc.) shall be made with individual conductors. The devices shall not be used for "feed-thru" purposes. Where "feed-thru" conditions exist, use "pig-tail" splices as described above. Color coding of "pig-tail" splices shall conform to Section 26 05 53, "Identification for Electrical Systems".
27. No splices or taps shall be made in any conductor except in outlet boxes, junction boxes, splice boxes, or other devices and equipment in exposed and accessible locations approved for the purpose by the latest edition of the NEC.
28. All wire connections or splices on conductors No. 18 AWG through No. 8 AWG shall be made with pre-insulated spring type connectors. No other type of mechanical connector shall be used for No. 8 AWG and smaller conductors.
29. All No. 6 AWG and larger copper conductors terminated on the "load" side lugs of all switchboard circuit devices, and the "line" and "load" side lugs of all other devices shall be terminated with set-screw type pressure connectors approved for the purpose.
30. All No. 6 AWG and larger copper conductors which are to be spliced or tapped in wireways, gutters, or junction boxes shall be spliced or tapped using hydraulically applied, high conductivity compression connectors, or with set-screw type pressure connectors approved for the purpose, using 3-M electrical tape or manufactured connector covers approved for the purpose.
31. The manufacturer's recommended installing tool shall be used for the installation of all hydraulically applied compression type lugs or connectors.
32. Support cables above accessible ceilings; do not rest on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure. Include bridle rings or drive rings.
33. Multiple circuit wires in bundles or harnesses terminating in control panels, switchboards, panelboards, etc., shall be loosely bundled, trained, and laced to achieve a neat and workmanlike appearance.
34. Surplus wire shall be trimmed to proper length. Do not fold and stuff surplus wires into wiring gutters.
35. Wires exiting harness shall be trained at 90 degree angles to termination point.
36. Refer to Section 25 05 53, “Identifications for Electrical Systems” for color coding and identification of conductors.

D. Type MC Cable:

1. Type MC cable may be used, where approved by the local authority having jurisdiction and allowed in the NEC: for drops in partitions to receptacles; for single circuit branch circuit wiring to individual receptacles; for lay-in fixture pigtails (10'maximum length); for switch leg drops; from fixture junction boxes to nonlay-in fixtures; or for single circuit branch circuit wiring from fixture to fixture (except lay-in fixtures) and fixture to junction box.
2. Type MC cable shall not be used for branch circuit homeruns. Type MC cable shall not be used for receptacle to receptacle wiring in partitions; where more than three conductors (phase/neutral/ground) are required; where exposed; or in lengths exceeding 20'.
3. Type MC cable in partitions shall be protected in accordance with the requirements of the NEC.
4. Type MC cable shall be supported as specified herein and in accordance with the NEC.
5. Refer to the Drawings for additional requirements concerning the use of Type MC cable.
6. Where MC cable is used for drops to line voltage switches provide a neutral conductor in the MC cable even if the neutral will not be used. Cap any unused neutrals for future use.

E. 300 Volt Control/Signal Cable and Wire:

1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings or other Division 26 sections. Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5' centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.
2. Remote control wires shall be no smaller than No. 14 AWG. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code required the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. This voltage drop shall be based on the full load, 70% power factor, the total impedance drop of 60 Hz alternating current and with the reactance drop in the respective metal conduits duly considered. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized representative.

3. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to Section 26 05 53, “Identification for Electrical Systems”, for additional requirements.

4. Make all splices and connections in stranded conductors using UL-approved solderless crimp connectors.

3.2 TESTING:

A. Feeder Insulation Resistance Test: Each new 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway (ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the following:

Wire Size (AWG)	Insulation Resistance (Ohms)
No. 12	1,000 K
No. 10 through No. 8	250 K
No. 6 through No. 2	100 K
No. 1 through No. 4/0	50 K
Larger than No. 4/0	25 K

2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.

B. Neutral Testing: After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:

1. The resistance of the system's neutral to ground shall be greater than 10 Kohms with the system bonding jumper disconnected.

2. Repeat neutral to ground test for neutrals of separately derived systems.

C. Pre-energization Check: Prior to energization, check all new branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.

D. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.

E. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions. Refer to Section 26 01 25, "Electrical Testing", for additional requirements.

3.3 AS BUILT DRAWINGS:

A. As-Built Drawings: Refer to Section 26 00 01, “Electrical General Provisions”, for applicable requirements.

3.4 IDENTIFICATION:

A. Identification: Refer to Section 26 05 53, “Identification for Electrical Systems”, for color-coding and markings for all conductors and cables.

END OF SECTION 26 05 19

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide electrical service, distribution, and equipment grounding as shown, scheduled, indicated, and as specified.

B. Types: The types of electrical service and equipment grounding specified in this Section include, but are not necessarily limited to, grounding all equipment and devices shown and as required by the National Electrical Code (NEC), the local electrical inspection department, and The Power Company.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following Standards:

1. ANSI/IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. ANSI/UL 467 - Safety Standard for Grounding and Bonding Equipment.
3. NFPA 70 - National Electrical Code (NEC).

1.4 QUALITY ASSURANCE:

A. NEC Compliance: Comply with Article 250 of the NEC for grounding.

B. Approval: All grounding shall be in accordance with the requirements of, and shall be subject to the approval of the Engineer and the local electrical inspection department.

C. UL Label: All grounding products shall be UL-labeled.

D. Manufacturers: Provide grounding products complying with these specifications and as manufactured by Copperweld and Cadweld.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. A complete grounding system diagram for special grounding systems.
2. Cut sheets of grounding products.
3. Additional information as required in Section 26 00 01, “Electrical General Provisions”..

1.6 STORAGE AND HANDLING:

A. Store grounding products in a clean, dry space.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: For each electrical grounding connection, provide a complete assembly of materials to construct a completely grounded electrical system.

B. Raceways: Raceways for grounding conductors shall be as specified in Section 26 05 33 "Electrical Raceways", and Section 26 05 34, "Electrical Boxes".

C. Cable, Wire, and Connectors: Grounding cable, wire and connectors shall be as specified in Section 26 05 19, "Low Voltage Conductors and Cables".

D. Ground Clamps: Ground clamps for connecting grounding conductors to copper, brass, or lead pipes shall be made of copper and if pipes are of steel or iron, the ground clamps should be made of galvanized iron. These clamps shall be designed to provide permanent and positive pressure and to avoid mechanical injury to the pipe. Use exothermic welds for connecting ground wires to ground rods, for all below grade counterpoise ground grids, and elsewhere where noted on the Drawings.

E. Ground Conductors and Jumpers: Grounding conductors and jumpers shall be connected to each other and to items to be grounded by means of approved type pressure connectors, clamps and other suitable methods approved by the Engineer. No solder connections shall be made.

F. Grounding Electrode Rods: Grounding electrode rods used shall be a minimum of 3/4" diameter by 10'long, steel core and thick copper jacket. All concrete encased or direct buried underground grounding electrode conductors shall be of lead alloy-coated copper, Class B, stranded, conforming to ASTM B8-11(2017).

G. Exothermic Welds: Use cadweld or an approved equal system of exothermic welding for welded grounding connections where shown on the Drawings or specified.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL GROUNDING:

A. General: Install grounding connections as shown and specified, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Grounding Electrode System: Each service neutral and ground bus shall be connected to the incoming cold water piping system to the building on the street side of the building water meter. Provide a bonding jumper around the water meter. The main grounding conductor shall be sized as shown and shall be run in conduit. The cold water pipe ground shall be supplemented as required by NEC, Article 250 H, and as required by the local inspection department. In addition, the lightning protection system ground rods specified in Section 26 41 13, "Lightning Protection for Structures", shall be interconnected with a bonding loop below the basement slab. This loop shall be bonded to the electric service ground and to the Power Company transformer ground rods.

C. Bonding: All metallic piping systems and building steel shall be effectively bonded to the electrical grounding system in accordance with Article 250 of the NEC. Install bonding jumpers to all piping systems and building steel.

D. Building Equipment Grounding System: The building equipment grounding system shall consist of the ground wire and electrically continuous metallic conduit system as shown. Every item of equipment served by the electrical system shall be bonded to the building equipment ground. Portions of metallic piping and duct systems which are electrically isolated shall be bonded to the equipment grounding system with a flexible bonding jumper.

E. System Neutral: The system neutral shall be grounded to the grounding electrode system at the service entrance only, and shall be kept isolated from the building grounding system throughout the building. The neutral of separately derived systems shall be grounded at one point as specified hereinbelow.

F. Miscellaneous: Provide bonding and grounding wires run in conduit and sized per the NEC in accordance with the local electrical inspection department and the NEC. Metallic piping and duct systems which enter the building shall be grounded at the point of entry to the building, in accordance with the NEC.

G. Continuity: Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be installed across conduit expansion fittings, all liquidtight flexible metal and flexible metal conduit, light fixture pigtails in excess of 6', and all other non-electrically continuous raceway fittings.

H. Main Conductors: All main grounding conductors shall be stranded copper conductors, sized as shown or per the NEC, and run in a suitable raceway. All main grounding conductors shall be continuous without joints or splices over their entire length.

I. Special Grounding: Provide special grounding systems where shown on the Drawings.

J. Separately Derived System Grounding: Bond the case and neutral of each transformer directly to the nearest available effectively grounded structural metal member of the structure, the nearest available effectively grounded metal water pipe, or in accordance with the local electrical inspection department. Flexible conduit shall not be used as a ground path to a transformer.

K. Standby Electric Power System: This is a separately derived system and shall have its neutral grounded to the generator frame.

L. Voice/Data Equipment Grounding: Provide a ground conductor from voice/data terminal provisions to the building grounding system as required by the local Telephone Company and as specified in Section.

M. LED Fixtures: Carefully and securely ground all fluorescent fixture bodies to the conduit grounding system. Flexible conduit longer than 6'shall not be considered a ground path.

N. Receptacles: Ground all grounding type receptacles with a separate ground wire, where present in the branch circuit. Further, ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the coverplate; or by the use of an approved grounding yoke type receptacle.

O. Motor Frames: Ground the frame of each motor with a properly sized separate ground wire around the liquidtight flexible conduit.

P. Rigid Nonmetallic Conduit Systems: Install a continuous grounding conductor in accordance with NEC.

Q. Feeder and Branch Circuits: Provide a separate, insulated equipment grounding conductor in each feeder or branch circuit. Terminate each end on a grounding lug, bus, or bushing.

R. Bolted Connections: Connections requiring bolting shall be made up with Monel metal bolts, washers, and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal. No strap grounding clamps shall be used.

S. Power Feeders: Ground the raceway, shield (where applicable), armor (where applicable), and ground conductors in 5/15 kV and 600 volt power feeders in accordance with the NEC. Bond all pull boxes and splice boxes in accordance with the NEC.

T. Branch Circuits: Install an insulated ground wire, sized per the NEC, in all branch circuits.

3.2 COORDINATION:

A. General: Coordinate installation of grounding connections for equipment with equipment installation work. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Connections: Use exothermic welds for connecting bonding and grounding conductors to ground rods, to counterpoise, structural steel, piping systems, and elsewhere where shown on the Drawings. Provide all accessories required for a complete installation.

3.3 TESTING:

A. Ground Resistance Test: Perform a ground resistance test on the building grounding systems for comparison to future inspection and testing data by the Owner. Service ground resistance shall not exceed 5 ohms. Overall system resistance shall not exceed 15 ohms. Test shall be performed using a Biddle Megger or equivalent test instrument operated in accordance with the test instrument manufacturers operating/test procedure. Test readings shall be taken after 30 and 60 seconds of Megger operation at slip speed. The test shall not be performed immediately following wet weather conditions.

B. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit two copies of certified test results for Owner's record and submit four copies of certified test results to Architect for review. Test reports shall include date and time of tests, relative humidity, test results, temperature, and weather conditions.

END OF SECTION 26 05 26

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 26 05 33 - ELECTRICAL RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide electrical raceway and fitting work as shown, scheduled, indicated, and specified.

B. Conduit Systems: All electrical conductors shall be installed in conduit except where metal clad Type MC cable or modular wiring is allowed or specified. Conduit shall be as specified herein. In addition, empty conduit shall be installed for the voice/data system and for other systems as indicated on the Drawings and in the Specifications.

C. Types: The types of electrical raceways and fittings required for the project include, but are not limited to, the following:

1. Rigid steel (RGS) and intermediate metal conduit (IMC).
2. PVC-coated rigid steel conduit.
3. Electrical metallic tubing (EMT).
4. Flexible metal conduit.
5. Liquidtight flexible metal conduit.
6. Rigid nonmetallic conduit.
7. Nonmetallic innerduct.
8. RTRC Fiberglass Conduit.

1.3 STANDARDS:

A. Products and installation shall comply with applicable sections of the following standards:

1.	ANSI C80.1	Electrical Rigid Steel Conduit (ERSC).
2.	ANSI C80.6	Electrical Intermediate Metal Conduit.
3.	ANSI C80.3	Electrical Metallic Tubing – Steel (EMT-S).
4.	ANSI/NEMA FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
5.	NEMA TC 3	PVC Fittings for Use with Rigid PVC Conduit and Tubing.
6.	NEMA TC14	Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Rigid Steel and Intermediate Metal Conduit:
    a. Allied Tube & Conduit Corporation.
    b. Republic Steel Corporation.
    c. Western Tube & Conduit Corporation.
    d. Wheatland.
2. PVC-coated Rigid Steel:
    a. CalConduit.
    b. KorKap.
    c. NEC Inc. BlackGuard.
    d. Plasti-Bond.
    e. Perma-Cote.
    f. Thomas & Betts.
3. Electrical Metallic Tubing:
    a. Allied Tube & Conduit Corporation.
    b. Republic Steel Corporation.
    c. Western Tube
    d. Wheatland.
4. Flexible Metal and Liquidtight Flexible Metal:
    a. AFC Cable Systems.
    b. Alflex
    c. Anaconda Universal.
    d. Electri-Flex Company.
    e. HellermannTyton FlexiGuard.
    f. Wheatland.
5. Rigid Nonmetallic Conduit and Innerduct:
    a. Carlon.
    b. Cantex.
    c. Triangle Wire & Cable.
6. Raceway Fittings:
    a. Appleton - Emerson

b. Cantex (PVC).

c. Carlon (PVC).

d. Cooper Crouse-Hinds.

e. I-T-E Imperial Corporation EFCOR Division.

f. OZ-Gedney - Emerson.

g. Hubbell-Raco, Inc.

h. Republic Steel Corporation.

i. Steel City.

j. Orbit Industries, Inc.

k. Thomas & Betts Company.

7. Ductbank Spacers:

a. Formex Manufacturing, Inc.

b. Carlon.

8. Precast Manholes, Pull Boxes and Accessories:

a. Brooks.

b. A. B. Chance.

9. RTRC Conduit

a. Champion Fiberglass

b. United Fiberglass

B. UL Label: All electrical raceways and fittings shall be UL-listed and labeled.

C. NEMA Compliance: All electrical raceways and fittings shall comply with NEMA standards applicable to raceway construction.

D. NEC Compliance: All electrical raceways and fittings shall comply with NEC requirements applicable to construction and installation.

1.5 SUBMITTALS:

A. Shop drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of electrical raceways and fittings selected from the manufacturers listed herein. The Contractor may install conduit and fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets of electrical raceways and fittings.

3. Manufacturers data on manholes, pull boxes and accessories.

4. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 STORAGE AND HANDLING:

A. Handle raceways and fittings carefully to avoid damage, breaking, denting and scoring. Damaged materials shall not be installed.

B. Store raceways and fittings in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General:

1. Provide metal conduit, tubing, and fittings of the type, grade, size, and weight (wall thickness) as shown and required for each service. Where type and grade are not indicated, provide proper selection determined by this Section to fulfill the wiring requirements and complying with the NEC for electrical raceways.

2. For each electrical raceway system indicated, provide a complete assembly of conduit, tubing, or duct with fittings, including, but not necessarily limited to, connectors, nipples, couplings, expansion fittings, bushings, locknuts, other components and accessories as needed to form a complete system of the type indicated.

3. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, except insulated throat grounding bushings shall be used on all conduits without ground conductors and where required by N.E.C. Article 250.

B. Rigid Steel or Intermediate Metal Conduit: Rigid Steel shall be UL 6 and ANSI C80.1, hot-dipped galvanized steel. Intermediate Steel shall be UL 1242 and ANSI C80.6, hot-dipped galvanized steel. Both ends of conduits shall be threaded with factory-installed thread protectors. Fittings shall be threaded Type UL 6/1242 and ANSI C80.1 and C80.6, hot-dipped galvanized steel. Expansion fittings shall be OZ Type "DX", Appleton Type "XJ", Crouse-Hinds Type "XC" or an approved equal and shall have bonding jumpers.

C. PVC Externally-Coated Rigid Steel Conduit: Shall be ANSI C80.1 hot-dipped galvanized rigid steel conduit with an external 0.040" minimum PVC protective coating per NEMA Standard RN1. Both ends of conduit shall be threaded and thread protectors shall be factory-installed. Fittings shall be threaded type ANSI C80.4, hot-dipped galvanized with a 0.055" minimum PVC coating to match the conduit.

D. Electrical Metallic Tubing: Shall be UL 797 and ANSI C80.3 galvanized steel with plain ends. Fittings, couplings and connectors shall be UL 797 and ANSI C80.4 galvanized steel type. Fittings, couplings and connectors shall be all steel set-screw type. All EMT connectors shall have insulated throats or bushings.

E. Flexible Conduit:

1. Flexible Metal Conduit: UL 1, zinc-coated steel

2. Flexible Metal Conduit Fittings: UL 1, zinc-coated steel, insulated throat.

3. Liquidtight Flexible Metal Conduit: Liquidtight flexible metal conduit comprised of single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquidtight jacket of flexible polyvinyl chloride (PVC) or neoprene.

F. Liquidtight Flexible Metal Conduit Fittings: UL 1, liquidtight, zinc-coated steel, neoprene gaskets and O-rings, insulated throat.

G. Nonmetallic Conduit and Fittings:

1. Schedule 40 Rigid PVC Conduit: Per UL 651, and NEMA TC 2, 90°C conductor temperature rating.

2. Schedule 80 Rigid PVC Conduit: Per UL 651 and NEMA TC 2, 90°C conductor temperature rating.

3. Type "EB" Encased Burial PVC Conduit: Per UL 651A and NEMA TC 8, ASTM F512 - heavy wall, 90°C conductor temperature rating.

4. PVC Conduit Fittings: Per NEMA TC 3 and compatible with PVC conduit system.

5. Ductbank Spacers: Spacers shall be interlocking plastic designed for the conduit sizes and nominal 3" spacing being used.

H. Nonmetallic Innerduct:

1. Innerduct: PVC corrugated flexible conduit, Carlon Optic-Gard PVC or an approved equal. Duct shall be available in one inch (1"), 1-1/4", 1-1/2" and 2" sizes and orange, gray and white colors.

2. Couplings: PVC type, external, solvent cement type.

I. Conduit Tubing Accessories: Provide ANSI/NEMA FB I conduit and tubing accessories including straps, hangers and expansion joints as recommended by the conduit and tubing manufacturer and as specified in this Section.

J. Precast Concrete Manholes:

1. General: Provide precast concrete manholes as detailed on the Drawings and as required for installation of new ductbank systems and connection to existing ductbank systems at locations shown on the Drawings.

2. Design: Manholes shall be steel reinforced and the complete manhole assembly shall be designed for H-20-44 bridge loading. Submittals shall clearly indicate all dimensions and reinforcing steel.

3. Concrete: Manholes shall be constructed using concrete with a 4500 psi 28 day strength. Concrete mix shall be designed in accordance with ASTM standards.

4. Reinforcing Steel: Steel shall be intermediate or hard grade billet steel conforming to ASTM A615/A615M, deformed in accordance with ASTM A305.

5. Manholes: Manhole and pull box covers shall be cast iron cover mounted in a 30" Type "B" or "WRM" frame and shall be traffic type for heavy vehicular traffic. The frame and neck shall be doweled into the manhole to prevent movement away from the

opening. Power manhole and pull box covers shall be marked "ELECTRIC". Communication manhole and pull box covers shall be marked "COMMUNICATIONS". Voice manhole and pull box covers shall be marked "TELEPHONE". Data manhole and pull box covers shall be marked "DATA".

6. Conduit Entry: Plastic conduits shall include a bell end inside the manhole or pull box, mounted flush and grouted to seal openings. Precast fiber type terminators shall be provided for each ductbank entry.

7. Grounding: A #4/0 bare copper ground wire shall penetrate the side wall in the bottom section of each manhole and pull box and extend 48" inside and outside of the manhole pull box.

8. Accessories: Knockouts, cable racks, sumps, steps, joint seals and other accessories shown on the Drawings or required for a complete installation shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install electrical raceways and fittings as shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, and in accordance with recognized industry practices to ensure that products serve the intended function. Complete electrical raceway installation before starting the installation of wire and cable.

B. Conduit Size: Minimum conduit size for power wiring shall be 3/4", except that 1/2" flexible metallic conduit may be used for fixture whips. Maximum conduit size for EMT shall be 4". Minimum conduit size for control wiring shall be 3/4". Minimum conduit size for voice/data wiring shall be 1 1/4".

C. Rigid Steel and Intermediate Metal Conduit: Use rigid steel or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage; and where cast in concrete walls or floor slabs which have waterproof membranes and where cast in masonry walls. Use rigid steel conduit for all power feeders, unless otherwise noted. Use rigid steel or IMC conduit for all feeders. IMC conduit shall not be used in sizes larger than 4". Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable. EMT conduit may be used instead of rigid steel or IMC for 600 volt feeder raceways, if the location is acceptable for use of EMT as described herein below, and if a properly sized ground wire is included with the feeder conductors in the EMT raceway.

D. PVC-coated Rigid Steel: Use polyvinyl chloride (PVC) externally-coated rigid steel conduit and fittings for electrical raceway systems for branch circuits to wet areas; and elsewhere, as shown. Conduit and fittings shall be installed such that the PVC-coating is continuous and watertight such that no portion of the metal conduit or fittings is exposed to moisture.

E. Electrical Metallic Tubing (EMT): Use EMT for branch circuit electrical raceway systems where concealed in furred ceilings or in walls; exposed inside where not exposed to physical damage; or cast in concrete walls or floor slabs which do not have waterproof membranes. EMT conduit shall not be installed where exposed to weather or in wet locations. Use set-

screw type fittings, couplings and connectors made-up tight for all conduit sizes. Use watertight fittings, couplings and connectors where required. Where cast in concrete and floor slabs, use concrete tight fittings, couplings and connectors and terminate conduit in a box cast in concrete, or with rigid steel conduit turnouts from concrete. Crimp type fittings, couplings and connectors are not acceptable.

F. Flexible Metal: Use flexible metal conduit (with internal ground wire) and fittings for lay-in lighting fixture connections and for other electrical equipment connections where subject to movement and vibration, but where liquidtight flexible metal conduit is not specified. Use flexible metal conduit in such lengths as required, 6'-0" maximum length and 3'-0" minimum length. 1/2" diameter conduit may be used for lighting fixture "pigtails".

G. Liquidtight Flexible Metal: Use liquidtight flexible metal conduit and fittings for all motor connections and for other electrical equipment connections where subject to movement and vibration and when subject to one or more of the following conditions: exterior location; moist or humid atmosphere where condensate can be expected to accumulate; corrosive atmosphere; subject to water spray; subject to dripping oil, grease or water. Install internal ground wire in flexible conduit with grounding bushings. Maximum length shall be 6'-0" and minimum length shall be 3'-0".

H. Rigid Nonmetallic: Use PVC conduit directly buried in earth, concrete encased, cast in concrete slabs, and where subject to corrosive environment. Use Schedule 40 where direct buried and Schedule 80 where exposed, with size adjusted to have same fill area as if Schedule 40 were used. Type "EB" encased burial duct shall be used in concrete encased applications where shown on the Drawings.

I. RTRC Conduit: Use RTRC conduit for underground applications (UL 2420) and above ground (UL2515) use in wet locations of dairies, laundries, canneries and cooling towers. Also use for elbows coming from underground PVC conduit. Use XW Type for areas of extreme physical damage and Class 1 Division 2 locations. Also use in areas of severe corrosive influences. Conduit may also be used for vertical risers on electrical service poles. All RTRC conduit shall be marked for (AG) above ground use.

3.2 INTERIOR CONDUIT SYSTEM:

A. Ground all metallic conduit in accordance with the requirements of the latest edition of the NEC.

B. Install all conduit as a complete system without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in such a manner as to ensure a tight joint. Field-cut threads shall be cold-galvanized after cutting. The entire conduit system shall be secured at all joints and boxes in such a manner that each system shall be electrically continuous throughout. Fasten the entire conduit system securely into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting. Install approved expansion fittings in all conduit runs as specified in paragraph 3.2/P.

C. Ream all ends of conduit properly to remove rough edges. Whenever a rigid steel or IMC conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by

the use of a locknut inside and outside and an approved insulating bushing shall be installed. Insulated grounding bushings shall be installed on all conduits without ground conductors and where required by NEC Article 250. Whenever an EMT conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by use of an insulated throat connector or a connector with an insulating bushing. Lay out and install all conduit systems as to avoid all other services or systems, the proximity of which may prove injurious to the conduit or the wires or conductors which the conduit confines.

D. Conceal conduit systems in finished areas. Concealed metallic conduits shall be run in a direct manner, basically parallel to, and at right angles with the lines of the building, and with as long a bend as possible. Conduit may be exposed in mechanical rooms and where otherwise shown or indicated. On exposed systems, run the conduit parallel or perpendicular to the structural features of the building and rigidly support with malleable iron conduit clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners insofar as practicable. All bends shall be field-made using an approved bending machine designed for the purpose, or using standard ells having a radius not less than that shown in Chapter 9, Table 2 of the National Electrical Code, and with approved fittings or connectors. All bends shall be free from dents or flattening.

E. All conduit shall be run without traps. Where traps are unavoidable, a junction or pull box shall be placed at the low point. Metallic conduit systems which are exposed to the weather or water shall be made watertight. As soon as conduit has been permanently installed in place, conduit shall be capped or plugged with standard accessories. All metallic conduit shall be swabbed after plaster and dry wall is finished and dry.

F. Support exposed raceway or grouped concealed raceways on galvanized channel using compatible galvanized fittings (bolts, beam clamps and similar items) and galvanized threaded rod pendants to secure raceway to channel and channel to structure. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt/nut and threaded rod. Support-spacing shall not exceed 10' apart for all EMT/IMC conduit and rigid conduit 2" and smaller and 15' apart for rigid conduit 2-1/2" and larger and within 3' from boxes and changes in direction. Support flexible conduit on maximum 4-1/2' centers and within one foot (1') of boxes. All raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on all conduit passing through walls and ceilings in finished areas.

G. Support 1" and smaller EMT conduit concealed in ceiling cavities with No. 13 AWG galvanized iron wire pendants, spaced not to exceed 10' apart and 3' from boxes and changes in direction, secured to conduit with clips and properly secured to structure. Perforated strap shall not be used for conduit supports. Branch circuit EMT conduit 3/4" trade size and smaller may be suspended using "caddy clips" attached to the ceiling support system in a manner acceptable to the ceiling contractor. Support conduit sized one inch (1") and larger as described in Paragraph F.

H. Make all joints and connections to ensure mechanical strength and electrical continuity. PVC conduit shall be joined, or have fittings attached, by using a fusing (solvent) compound recommended by and applied as instructed by, the conduit manufacturer.

I. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8" clear. Whenever possible, install horizontal raceway runs above water piping. Unless shown otherwise, do not install conduit horizontally in concrete slabs without written approval. All roof penetrations shall be made in adequate time to allow the roofer to make proper flashings.

J. Carefully review architectural, structural, mechanical, plumbing, and electrical Drawings and place boxes and conduit to avoid conflicts with structural members or other general construction.

K. Conduit shall not be embedded in structural slabs without prior written permission from the Structural Engineer. Conduits embedded in structural slabs shall be installed in the middle of the slab below the top and above the bottom reinforcing steel. Maintain a minimum concrete coverage of one inch (1") except where penetration is made.

L. Furnish sleeves for timely placing in construction for all conduit passing through concrete walls, partitions, beams, floors, and roofs while same are under construction.

M. All conduit passing through the housing on connected equipment, shall pass through a cleanly cut hole protected with an approved grommet.

N. Metallic conduit installed below grade shall have its entire length painted with two coats of protective finish unless encased in concrete. Each coat shall consist of 5 mils of PPG "Coat Cat Epoxy Coating" applied in accordance with the manufacturer's recommendations. The entire length of metallic conduit, including fittings, shall be protected to a point 6" above finished grade (or concrete slab).

O. Coordinate locations of raceways in fire rated partitions so as not to affect the fire rating of the partition. Notify the Architect in writing where additional construction is required to maintain the partition fire rating.

P. Install expansion fittings in all conduit as follows:

1. All conduits crossing building expansion joints; unless some other form of thermal expansion compensation is approved in writing by the Engineer.
2. All conduit straight runs in excess of 200' and on 400' centers in all longer conduit runs.
3. Conduits entering environmental rooms.
4. Locations subject to thermal expansion and as required by NEC.
5. Unless expansion fitting has an integral bonding braid an external braid, approved for the purpose, shall be installed around the fitting.

3.3 EXTERIOR CONDUIT SYSTEMS:

A. Exterior conduit systems shall meet all of the general installation requirements for interior conduit systems.

B. All exterior conduit systems shall be completely watertight. All hangers, fasteners, and supports used with exterior conduit systems shall be hot dip galvanized.

C. Conduit routed across roofs shall be attached to 4" x 4" redwood or penta-treated pine sleepers spaced on maximum 5'-0" intervals, unless otherwise detailed on the Drawings. Sleepers shall be installed in pitch pans or as otherwise detailed on the Drawings.

D. Install underground conduits with sealing glands equal to OZ Type "FSK" or approved equal, exterior to the conduits and OZ Type "CSB" or approved equal internally at the point where conduits enter the building, to prevent water seepage.

E. Install conduits outside the building lines a minimum of 36" below grade, unless noted otherwise on the Drawings. Maintain 12" of earth or 2" of concrete separation between electrical conduits and other services or utilities below grade. Maintain 10'-0" separation between parallel underground power and voice/data conduits. Where power and voice/data conduits cross below grade, crossing shall be at right (90 degree) angles with a minimum 2'-0" vertical separation.

3.4 POWER DUCTBANK SYSTEMS:

A. Power ductbanks shall be of individual conduit encased in reinforced concrete. Conduit shall be rigid PVC Schedule 40 except that rigid steel conduit shall be used for the final 10' at the beginning and end of each ductbank and for all 90 degree elbows. Unless shown otherwise, the type of conduit used shall not be mixed in any one ductbank and shall be not smaller than 4" in diameter. The reinforced concrete encasement surrounding the ductbank shall be rectangular in cross section, having a minimum concrete thickness of 3". Conduit shall be separated by a minimum concrete thickness of 2", except that light and power conduit shall be separated from control and signal conduits by a minimum concrete thickness of 3". Encasement concrete shall be red in color.

B. The power ductbank shall be routed underground and the top of the concrete envelope shall be not less than 36" below grade.

C. Changes in direction of ductbank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5'. All bends in a run shall be separated by a minimum of 10' of straight conduit, where possible.

D. During construction, partially completed ductbanks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the ductbank is completed, a testing mandrel shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed.

E. Ducts in concrete encased ductbanks shall be independently supported by interlocking module spacers by Formex or equal. Spacers shall provide separation between adjacent ducts as specified hereinabove. Spacers shall be installed at 6' maximum intervals.

F. Ducts in concrete encased ductbanks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators by Formex or equal. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place.

G. Install underground conduits with sealing glands equal to OZ Type "FSK" exterior to the conduit and OZ Type "CSB", or equal internally at the point where conduits enter the building to prevent water seepage into the building.

H. Furnish the exact dimensions and location of power ductbank to be encased in time to prevent delay in the concrete work.

I. Power ductbank shall be installed per Power Company standards.

3.5 VOICE/DATA DUCTBANK SYSTEMS:

A. Exterior voice/data ductbanks shall be of individual PVC conduit and direct buried without concrete encasement. Conduit shall be rigid PVC Schedule 40. Interior ductbanks shall be of individual conduit and conduit shall be EMT. Unless shown otherwise, the type of conduit used shall not be mixed in any one ductbank and shall not be smaller than 4" in diameter. Install innerducts and pullstrings in conduit and ductbank where noted.

B. Where the voice/data ductbank is routed underground, the top of the ductbank shall be not less than 36" below grade.

C. Changes in direction of voice/data ductbank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5'. All turn ups to above grade shall be long radius RGS elbows, coated as specified in paragraph 3.2N. All bends in a run shall be separated by a minimum of 10' where possible. There shall be no more than two 90 degree bends in any run of voice/data ductbank.

D. During construction, partially completed ductbanks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the ductbank is completed, a testing mandrel with diameter 1/4" smaller than the conduit shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed.

E. Sleeves for voice/data ductbank passing through basement walls shall be rigid steel conduit and shall extend a minimum of 24" outside basement wall.

F. Ducts in concrete encased ductbanks shall be independently supported by interlocking modular spacers. Spacers shall provide separation between adjacent ducts as shown on the Drawings. Spacers shall be installed at 6' maximum intervals.

G. Ducts in concrete encased ductbanks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place.

H. Voice/data ductbank shall be installed per Telephone Company standards.

3.6 DUCTBANK MANHOLES AND PULL BOXES:

A. Install manholes and pull boxes in accordance with the manufacturer's written installation instructions. Manholes shall be rigidly supported and level with the top of manhole rings flush with finished paving or grade at the point of installation.

B. Seal all joints and openings to prevent the entry of water.

3.7 VOICE/DATA AND SIGNAL SYSTEM RACEWAYS:

A. General: Conduit shall be installed in accordance with the previous specified requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 100' for 1/2" and 3/4" trade sizes, and 150' for one inch (1") or larger trade sizes, and shall not contain more than two 90 degree bends or the equivalent thereof. Pull or junction boxes shall be installed to comply with these requirements. Empty voice/data and signal system raceways shall include a pull wire or cord, as described in Paragraph 3.8 hereinbelow. Install innerducts with pullcords in raceways where noted.

3.8 EMPTY CONDUIT RACEWAY SYSTEMS:

A. General: Empty conduit in which wire is to be installed by others shall have pull wires installed. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic having not less than 200 pounds tensile strength. Not less than 12" of slack shall be left at each end of the pull wire.

3.9 IDENTIFICATION:

A. General: Refer to Section 26 05 53, "Identification for Electrical Systems", for requirements concerning painting and marking of raceways and fittings.

END OF SECTION 26 05 33

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 26 05 34 - ELECTRICAL BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide electrical box and fitting work as shown, scheduled, indicated, and as specified.

B. Types: The types of electrical boxes and fittings required for the project include, but are not limited to, the following:

1. Outlet boxes.
2. Junction boxes.
3. Pull boxes.
4. Cabinets.
5. Floor boxes.
6. Fire-rated poke-thru boxes.
7. Conduit bodies.
8. Bushings.
9. Locknuts.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. ANSI/NEMA OS 1 -Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
2. NEMA 250 -Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Interior Outlet Boxes:
   a. Appleton - Emerson.
   b. Arrow Hart - Eaton.
   c. Bowers – Thomas & Betts.
   d. OZ-Gedney - Emerson.

e. National Electric & Products Company.
f. Hubbell-Raco
g. Star Sheet Metal.
h. Orbit Industries, Inc.
i. Steel City – Thomas & Betts.

2. Weatherproof Outlet Boxes:
   a. Appleton - Emerson.
   b. Cooper Crouse-Hinds Company.
   c. Harvey Hubbell, Inc.
   d. Steiner Pyle-National Company.
   e. Hubbell-Raco
   f. Red Dot – Thomas & Betts.
   g. Orbit Industries, Inc.
3. Junction and Pull Boxes:
   a. Appleton -Emerson.
   b. Arrow Hart - Eaton.
   c. OZ Gedney - Emerson.
   d. General Electric Company.
   e. Hoffman Engineering Company.
   f. Square D Company.
   g. Unity Manufacturing.
   h. Orbit Industries, Inc.
4. Cabinets:
   a. General Electric Company.
   b. Hoffman Engineering Company
   c. Square D Company.
   d. Westinghouse.
   e. Orbit Industries, Inc.
5. Floor Boxes:
   a. Hubbell.
   b. Legrand – Wiremold.
   c. FSR.
   d. Orbit Industries, Inc.

6. Fire-rated Poke-thru Boxes:
   a. Hubbell.
   b. Legrand – Wiremold.
   c. FSR.
   d. Orbit Industries, Inc.
7. Conduit Bodies:
   a. Appleton - Emerson.
   b. Cooper Crouse-Hinds Company.
   c. Hubbell-Killark.
   d. Steiner Pyle-National Company.
   e. Orbit Industries, Inc.
8. Bushings, Knockout Closures and Locknuts:
   a. Allen-Stevens Conduit Fittings Corporation.
   b. Allied Metal Stamping, Inc.
   c. Appleton - Emerson.
   d. Carr Company.
   e. Hubbell-Raco, Inc.
   f. Steel City – Thomas & Betts.
   g. Thomas and Betts.
   h. Orbit Industries, Inc.

B. UL Label: All electrical boxes and fittings shall be UL-labeled.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review, a list of proposed manufacturers of electrical boxes and fittings selected from the manufacturers listed herein. The Contractor may install electrical boxes and fittings furnished by any manufacturer listed on the approved submittal.
   2. Cut sheets of electrical boxes and fittings.
   3. Cut sheets on cabinets.
   4. Drawings of any special boxes which must be fabricated, including construction details.
   5. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 STORAGE AND HANDLING:

A. Handle electrical boxes and fittings carefully to avoid damage, breaking, denting, and scoring. Damaged equipment or materials shall not be installed.

B. Store electrical boxes and fittings in a clean dry space and protect from weather.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

A. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Provide "gang" boxes where devices are shown to be grouped.

1. Type for Various Locations:

   a. Ceilings: 4" square, 2-1/8" deep.

   b. Standard Partitions, Where 1/2" and 3/4" Conduits are Employed: 4" square by 2-1/8" deep boxes with one-gang or two-gang plaster covers shall be used.

   c. Thin Partitions Measuring 3-1/2" or Less: 4" square by 1-1/2" deep boxes with one-gang or two-gang covers shall be used.

   d. Standard Partitions, Where Conduits of a Size Greater than 3/4" are Employed: 4-11/16" square by 2-1/8" deep boxes with one-gang or two-gang plaster covers shall be used.

   e. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.

   f. Poured Concrete: Provide plenum type boxes without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

   g. Return Air Ceiling Plenum Boxes: In return air ceiling plenums, where 1/2" and 3/4" conduits are employed, 4" square by 2-1/8" deep plenum boxes shall be used.

   h. Surface: Type "FS" or Type "FD" box with surface cover.

   i. Special: Where above types are not suitable, furnish boxes to suit the use taking into account space available, appearance, and Code requirements.

2. Switch Boxes:

   a. One-gang/Two-gang Switch Boxes in Standard Walls or Partitions: Shall be 3" x 2" square corner boxes by 2-1/2" deep with appropriate mounting bracket for attachment to studs.

   b. One-gang/Two-gang Switch Boxes in Thin Walls or Partitions: Shall be 3" x 2" square corner boxes by 1-1/2" deep with appropriate mounting bracket for attachment to studs.

   c. Three-gang and Up Switch Boxes in Standard Walls or Partitions: Shall be 4-1/2" wide solid gang boxes, with appropriate "gang" plaster covers as required.

3. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including proper covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for all boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used, and meeting requirements of individual wiring situations.

B. Weatherproof Outlet Boxes: Provide hot-dipped galvanized cast iron weatherproof outlet wiring boxes, of the type, shape, and size, including depth of box, with threaded conduit ends, cast metal coverplate with spring-hinged waterproof caps suitably configured for each application, including face plate gasket and corrosion resistant fasteners.

C. Junction and Pull Boxes: Provide galvanized sheet steel junction and pull boxes, with screw-on covers and welded seams with stainless steel nuts, bolts, screws and washers, of the type, shape, and size, to suit each respective location and installation.

1. Type for Various Locations:

a. 100 Cubic Inches in Volume or Smaller: Standard outlet boxes with stamped knockouts.

b. 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown to have hinged doors. Hinged doors with locking device same as furnished on panelboards. Knockouts factory-stamped or formed in field with a cutting tool to provide a clean symmetrically-cut hole.

c. Exterior or Wet Areas: Weatherproof galvanized steel construction with proper gaskets and corrosion resistant fasteners. A parking garage is considered a wet area.

D. Cabinets: Provide cabinets of size and style noted on the Drawings.

1. Cabinet fronts shall be steel. Other sheet metal for boxes shall be galvanized steel. Details of construction and methods of assembly shall meet the requirements of the Underwriters' Laboratories, Inc.

2. The panel doors of cabinets shall be provided with locks. Single panel doors of cabinets shall have a lock with ring pull. Single doors 48" or longer and pairs of doors shall have a lock with vertical bolt operation, 3-point locking. Locks shall be keyed alike. Two keys shall be supplied for each cabinet.

3. Cabinets shall have concealed hinges.

4. Flush-mounted trim shall be fastened to cabinet with adjustable trim clamps. Fasteners for cabinets in concealed areas shall be concealed.

5. Each voice/data cabinet shall be equipped with 3/4" plywood backboard covering entire inside rear surface and painted matte white.

6. Trims and doors shall have a suitable primer coat and a finish coat of the manufacturer's standard color.

E. Floor Boxes: Provide fully adjustable floor boxes for installation in concrete floors as indicated. Boxes shall be adjustable both before and after the concrete pour. Provide boxes to suit devices shown and as scheduled on the Drawings.

F. Fire-rated Poke-Thru Boxes: Fire-rated, UL-listed poke-thru boxes for installation through concrete slabs. Boxes shall be suitable for the slab thickness of the building and shall have UL-listed abandon plates for use where boxes are removed. Provide poke-thru boxes to suit devices shown and as scheduled on the Drawings.

G. Conduit Bodies: Provide galvanized cast metal conduit bodies, of the type, shape and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion resistant screws.

H. Bushings, Knockout Closures, and Locknuts: Provide corrosion resistant punched-steel box knockout closures, conduit locknuts, gasketed locknuts, insulated conduit bushings and insulated grounding conduit bushings of the type and size to suit each respective use and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS:

A. Install electrical boxes and fittings as shown, in compliance with NEC requirements, or in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes. Where boxes are concealed in exterior walls, the continuity of the vapor barrier shall be maintained behind the box.

B. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes may be located.

C. Determine from the Drawings and by actual determination on the site, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modification to center them within room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination. Check these conditions throughout the entire job and notify the Architect of discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation of the work. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required to extend boxes to the finished surfaces of special furring or wall finishes.

D. Install outlet boxes at heights as specified in Section 26 05 01, "Electrical Basic Materials and Methods".

E. On exposed conduit systems provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.

F. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.

G. Provide knockout closures to cap unused knockout holes where blanks have been removed.

H. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

I. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Two gang (single or double device) boxes may be connected

to one stud using an approved bracket, except where specific dimensioned locations must be met. Box recessing depths shall comply with Article 314.24 of the National Electrical Code.

J. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork, or mechanical piping.

K. Provide junction and pull boxes for feeders and branch circuits where shown and where required by the NEC, regardless of whether boxes are shown or not.

L. Coordinate locations of boxes in fire rated partitions and slabs so as to not affect the fire rating of the partition or slab. Notify the Architect in writing where modifications or additional construction are required to maintain the partition or slab fire rating.

M. All junction boxes in accessible locations shall be marked with a permanent marker to identify the circuit(s) within the box.

N. Junction boxes utilized for emergency circuits shall be painted red in color.

O. Do not install boxes back-to-back in walls. Provide minimum 6" separation. Provide minimum 24" separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the boxes and pack openings with fiberglass.

P. The following requirements shall apply to exposed as well as concealed conduit systems when "gang" boxes shall be used. These "gang" boxes shall have dimensions which are not smaller than those shown in the following table:

NUMBER IN GANG	SIZE
3	4-1/2" x 8-5/8"
4	4-1/2" x 10-1/2"
5	4-1/2" x 10-1/2"
6	4-1/2" x 14"

Q. Switch boxes shall not be used as junction boxes.

R. Install boxes in walls without damaging wall insulation.

S. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

T. In inaccessible ceiling areas, position outlets and junction boxes within 6" of recessed luminaire, to be accessible through luminaire ceiling opening.

U. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Light fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

V. Set floor boxes level and flush with floor. Install nonrated floor boxes as detailed on the Architectural Drawings.

W. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

X. Where outlet or switch boxes are not supported from studs or joists directly, they shall be supported by expandable clip type bar hangers, Appleton Catalog No. SX-18 or SX-26. In no case shall conduit be used to support switch or outlet boxes.

Y. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8" plaster covering back of box.

Z. Refer to Section 26 05 53, “Identification for Electrical Systems”, for applicable painting and marking of electrical boxes.

END OF SECTION 26 05 34

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide identification for electrical systems as shown, scheduled, indicated, and specified.

B. Types: The types of identification for electrical systems required for the project include, but are not limited to:

1. Electrical system identification.
2. Warning signs and operational tags.
3. Cleaning and painting of electrical work.

1.3 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Cut sheets and samples of Electrical System Identification products.
2. Additional information as required in Section 26 00 01, “Electrical General Provisions”..

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver components in factory-fabricated water resistant packaging.

B. Handle components carefully to avoid damage to components, enclosures, and finish.

C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General: Refer to PART 3 - EXECUTION of this Section and other Division 26 sections for basic electrical products and materials.

PART 3 - EXECUTION

3.1 ELECTRICAL SYSTEM IDENTIFICATION:

A. Identification of Equipment:

1. All pieces of major electrical equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.

2. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, junction boxes, etc., by marking them. All items of equipment, pull boxes, junction boxes, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings, where applicable.
3. Equipment nameplates shall be three ply laminated plastic, a minimum of 3/32" thick, black-white-black for normal power, red-white-red for emergency power, and blue-white-blue for UPS power. Letters shall be similar to Roman Gothic of a size that is legible (1/2" minimum for main nameplates and 3/8" minimum for branch device nameplates) and appropriate to the application. Attachment of nameplates shall be by stainless steel screws. Rivets or adhesives are not acceptable. Nameplates on equipment installed in finished areas shall be installed inside equipment. Verify location with the Engineer.
    a. Electrical equipment to be identified includes: All switchboards, distribution panels, transformers, panelboards, automatic transfer switches, disconnect switches, motor controller/starters, lighting control panels, pull boxes, junction boxes, and similar equipment.
    b. Nameplates on switchboards, automatic transfer switches, transformers, distribution panels, disconnect switches, motor controller/starters, and panelboards shall give voltage and current characteristics and the source feeding the panel. Current characteristics shall indicate the size of the overcurrent devices serving the equipment and not the equipment current rating.

        Example:
        PANEL 1LA
        120/208V, 3 PH, 4 W, 225 A
        Fed from DPA-3
        Room 1.102

    c. Individual overcurrent devices and pilot lights in switchboards, distribution panels, and similar equipment shall have nameplates showing the load served and its location, where remote. Nameplates on motor starters shall indicate variable speed, time delay operation, etc., where applicable.
    d. Blank nameplates shall be mounted on each spare or bussed space in motor control centers, and on each spare or space in distribution panels.
    e. Branch circuit panelboards shall have neatly typed circuit directories behind clear plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner; not necessarily those given on contract Drawings. Spares and spaces shall be indicated with erasable pencil; not typed. Circuit numbers shall be provided in the directory and at each circuit breaker.

B. Conduit Systems: Provide adequate marking of major conduit which is exposed or concealed in accessible spaces, to distinguish each run as either a normal power, emergency power, fire alarm, control wiring or voice/data conduit. Except as otherwise indicated, use orange banding with black lettering except that emergency power and fire alarm conduit markers shall use red banding. Provide self-adhesive or snap-on type plastic markers. Indicate voltage ratings of conductors exceeding 250 volts. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors,

at points where conduit passes through walls or floors, or enters non-accessible construction and at spacings of not more than 50' along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than one inch (1").

C. Cable Tray Systems: Provide engraved nameplates identifying cable tray systems as to use, on maximum 50’ centers on all exposed tray systems and whenever a tray enters a room or concealed accessible location. Nameplate text shall be submitted to the Engineer for review.

D. Underground Cable Identification: Bury a continuous, preprinted, bright colored plastic ribbon cable marker, Brady No. 91600 Series or an approved equal with each underground cable (or group of cables), regardless of whether conductors are in conduit or direct buried. Locate each directly over cables, 6" to 8" below finished grade. Ribbons shall be detectable from above grade using a pipe or cable locator.

E. Cable/Conductor Identification: Coordinate a uniform and consistent scheme of color identification of power wiring throughout the building system. Identification shall be by the permanent color of the selected covering. On large conductors, secure identification by means of painted color banding or plastic tape.

1. Color scheme shall be as follows:

	208/120 Volt	480/277 Volt	5 kV/15 kV
Phase A	Black	Brown	Black
Phase B	Red	Purple	Red
Phase C	Blue	Yellow	Blue
Neutral	White	Gray	White
Ground	Green	Green	

2. Wiring for switches shall be same color as phase wire.

3. Colored insulation in sizes up through No. 10. Conductors No. 8 and larger may have black insulation, but color coded with 1/2" wide band of colored tape, at accessible locations.

4. Feeder cables shall be tagged in pull boxes, wireways, wiring gutters of panels, and at other accessible locations. Tags shall be fireproof, nonconductive material, approved by Architect.

5. Maintain same conductor color from service entrance to last device.

F. Phase Rotation: Phase rotation shall be maintained throughout the project.

1. Phase rotation shall be clockwise or counterclockwise, per serving power company standards, A-B-C, and identified as such left-to-right, top-to-bottom, and front-to-back with color coding as specified above at switchboards, panelboards, substations, transformers, motor control centers, motor starters, and similar locations.

2. Motor phase reversal, if necessary, shall be made at motor terminals.

G. Branch Circuit and Control Wiring Tags: All branch circuit and control wiring conductors shall be tagged using self-sticking vinyl cloth or mylar cloth wire markers. Embossed pressure sensitive plastic or metal ribbon markers will not be accepted. Tags shall be installed at all wiring splice, tap and termination points and shall correspond to the designations shown on the control wiring diagrams or panel schedules.

H. Branch Circuit Pull Boxes and Junction Boxes: Branch circuit pull boxes shall be neatly stenciled with a black permanent marker indicating the panel name and branch circuit number. Boxes on emergency power systems shall be painted red prior to marking.

I. Manufacturers: Provide electrical identification products as manufactured by Ideal Industries, T&B, 3M, Panduit, Seaton, Emedco, or an approved equal.

3.2 WARNING SIGNS AND OPERATIONAL TAGS:

A. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.

B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: **"DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING"**.

3.3 CLEANING AND PAINTING OF ELECTRICAL WORK:

A. Prime, protective and touch-up painting is included in the Work of this Division. Finish painting in equipment spaces, concealed locations, and other locations not exposed to the view of building occupants is included in the work of this Division. Finished painting in areas exposed to the view of building occupants is specified under Division 9.

B. All equipment and materials furnished by the electrical subcontractor shall be delivered to the job with suitable factory protective finish.

C. Electrical switchgear, disconnect switches, contactors, etc., with suitable factory-applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect and in a color selected by the Architect. Where factory-applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using the spray process.

D. All equipment not finished at the factory shall be given a prime coat and then finish painted with two coats of enamel in a color as directed by the Architect/Engineer. No nameplates on equipment shall be painted, and suitable protection shall be afforded such plates to prevent their being rendered illegible during the painting operations.

E. The surfaces to be finish-painted shall first be prepared as follows:

1. Galvanized and black steel surfaces shall first be painted with one coat of galvanized metal primer.

2. Aluminum surfaces shall first be painted with one coat of zinc chromate primer.

F. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor and above ceilings shall be painted with two coats of zinc chromate primer as the construction progresses to protect against deterioration.

G. All junction and pull boxes and covers which are part of raceway systems distributing emergency power shall be painted red. Where a multiple branch emergency power system is

installed, the branch designation (LS, CB or EQ) shall be stenciled on the box cover in minimum one inch (1") high white letters.

H. All junction and pull boxes and covers and terminal cabinets which are part of the raceway/wiring system for fire alarm wiring shall be painted red. A system designation (FA) shall be stenciled on the box or cabinet cover in minimum one inch (1") high white letters.

I. All conduit exposed to view shall be finish painted as directed by the Architect/ Engineer.

J. Before painting, all surfaces to be painted shall be suitably prepared. This shall include removing all oil, rust, scale, dirt, and other foreign material. Surfaces shall be made smooth by grinding, filing, brushing, or other approved method. In the painting operations, the primer for metal surfaces shall be of the zinc dust type unless specified otherwise, and where finish painting is specified, it shall be painted using materials and colors selected and approved by the Architect/Engineer. Refer to Division 9 for additional requirements.

END OF SECTION 26 05 53

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SECTION 26 05 73 - SHORT CIRCUIT ANALYSIS/COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1. DESCRIPTION OF THE WORK:
   General:
   The Short Circuit Analysis, Protective Device Coordination Study, Emergency Power System Selective Coordination Study and Arc Flash and Electrical Hazard Studies specified in this section shall be completed and submitted prior to submitting submittals for switchboards, distribution panels, panelboards, enclosed circuit breakers and other electrical gear with short circuit or interrupting ratings.

2. The Electrical Contractor shall provide the Engineer with a Power System Short Circuit Analysis, Protective Device Coordination Study, Emergency Power System Selective Coordination Study and Arc Flash and Electrical Hazard Study. These analysis’s and studies shall include all power distribution systems, beginning at the electric service point from the Electric Utility Company and emergency power source(s) to the secondary buses of each panelboard as described hereafter.

3. The Short Circuit Analysis, Protective Device Coordination Study, Emergency Power System Selective Coordination Study and Arc Flash and Electrical Hazard Studies shall be prepared by and certified with a registration seal and signature of a Registered Professional Engineer. The Engineer shall be qualified by experience in preparation of studies having similar requirements and of similar magnitude to that specified in this section of the Specifications.

4. The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes, total source plus all motor contribution, is less than 10,000 amperes for 208/240 volts and 14,000 amperes for 480 volts. It is the intent of these Specifications to determine all locations in the entire electrical system where the symmetrical short circuit amperes meets or exceeds 10,000 amperes at 208 volts and 14,000 amperes at 480 volts. The short circuit analysis shall compare interrupting rating of all installed electrical protective devices connected to each bus included in the study with that of the available fault current at the load terminals of each protective device. Appropriate recommendations shall be made for corrective action in the conclusions of the report where the interrupting rating of electrical equipment is exceeded by the available fault current.

5. The Protective Device Coordination Study shall start at the electric service and include all electrical distribution equipment protective devices with adjustable trip units, relay settings or options for fuse types. The curves and settings for the Power Company protective devices shall be included in the scope of this study. The coordination plots shall terminate with the first non-adjustable overcurrent device or devices downstream of

all protective devices with an adjustable trip unit, relay settings or options for fuse types. The protective device study shall include a separate analysis for phase and ground protection.

6. The Emergency Power System Selective Coordination Study shall comply with all applicable NEC requirements and shall start at the electric service and emergency power source(s) and include all electrical distribution equipment protective devices to and including the final branch circuit protective devices serving applicable emergency loads. The curves and settings for the Power Company protective devices shall be included in the scope of this study. The coordination plots shall terminate with the final branch circuit protective devices serving applicable emergency loads. The protective device study shall include a separate analysis for phase and ground protection.
7. The Arc Flash and Electrical Hazard Study comply with applicable NEC and OSHA requirements and shall include calculating the Arc Flash and establishing the Electrical Hazard rating for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
8. The Contractor shall obtain all lengths of cable from the electrical drawings and, where not shown the entire length of the run, from Contractor estimated lengths. All other equipment ratings shall be obtained by the Contractor from the equipment manufacturer's and/or suppliers.

B. Short Circuit Analysis: The Analysis shall include the following:

1. A schematic one-line drawing of the entire electrical system included in the study, from the power company system including the point of delivery, to each primary transformer, and including all main secondary buses of each transformer included in the study. Secondary buses shall include multiple secondary transformations within the scope of the study. Each device shall be identified using project assigned identification labels. Each motor 10 hp and larger shall be shown and identified. Each bus shall be assigned an identification number.
2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on an assumed bolted 3 phase short circuit.
3. At each bus, including buses of all primary protective and switching devices, primary and secondary of all transformers, all secondary main and feeder breakers, and all secondary devices and panelboards within the scope of the study, the following shall be calculated for assumed bolted 3 phase short circuits.
    a. Symmetrical RMS short circuit amperes, calculated using total source and motor contribution reactance and resistance values.
    b. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
    c. Reactance ("X") and Resistance ("R") in OHMS at the voltage of the device being examined, including both The Power Company source and all motor contributions.
4. Calculation sheets for cable sections shall indicate voltage, wire size, cable length, reactance and resistance of the section in OHMS and total "X" and "R" to the source.

5. Calculation sheets for transformer sections shall indicate transformer kVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total "X" and "R" value in OHMS at the secondary voltage to source, including The Power Company source impedance plus any primary motor contribution.
6. Calculation sheets for busway and miscellaneous devices shall provide all pertinent parameters including operating voltage, section "X" and "R" values in OHMS, and total "X" and "R" values in OHMS to the source, based on source impedance plus any motor contribution.
7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, "X" and "R" values in OHMS including The Power Company plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ration, and asymmetrical factor.
8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor 10 hp and larger. Symmetrical short circuit amperes shall be given for each motor at the motor terminals.
9. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer. For this evaluation, circuit breakers shall all be fully rated**.**
10. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

C. Protective Device Coordination Study: The Study shall include the following:

1. All devices shall be fully selectively coordinated as required by the National Electric Code.
2. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
3. The Power Company's relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.
4. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.
5. Low voltage circuit breakers shall have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.
6. The coordination plots shall include significant motor starting characteristics and large motor protective devices.
7. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the

circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes as 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors. Conductor initial temperature and conductor maximum transient temperature for short circuits as recommended by ICEA shall be indicated.

8. High voltage relays shall have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.
9. A determination of settings or ratings for the overcurrent and ground fault protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection considered more important than service continuity. The time-current coordination analysis shall be performed with the aid appropriate software.
10. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
11. An evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied.
12. When main breaker is provided with setback to reduce the arc fault level both settings shall be included in the study.
13. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.

D. <u>Emergency Power System Selective Coordination Study</u>: The Study shall include the following:

1. **Confirmation of selective coordination of all overcurrent devices associated with supplying utility and generator/UPS to emergency loads in accordance with all applicable requirements of NEC Article 100 and Paragraphs 700.27 and 701.18. Study shall be based on full selective coodination. Study shall be based on the actual electrical equipment and overcurrent protective devices being submitted for the project.**
2. **Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.**
3. **Circuit breakers shall indicate manufacturer and type and have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current.**

4. **Fuses shall have fuse manufacturer and type indicated. Fuse curves shall be identified as either total clearing time or damage time as applicable.**
5. **High voltage relays shall indicate manufacturer and type and have have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.**
6. **A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.**
7. **Confirmation that the proposed overcurrent protection devices, set or selected as recommended, will provide the specified selective coordination. Should the overcurrent devices proposed for the project not be capable of providing the specified selective coordination, the report shall include recommendations for overcurrent protective device changes required to provide the specified coordination and calculations, plots, recommended settings as specified herein for the recommended overcurrent device changes to provide the specified selective coordination.**
8. **All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.**

E. Arc Flash & Electrical Hazard Analysis: The Analysis shall include the following:

1. The Arc-Flash & Electrical Hazard Analysis (AFEHA) shall be performed in accordance with the requirements of NFPA 70 Section 110.16, NESC ANSI C2-2007 Section 410.A.3, IEEE Std. 1584 and OSHA 29 CFR 1910.132(d) and 1910.335.
2. The AFEHA shall:
   a. Calculate incident energy levels and flash protection boundaries at all relevant equipment busses based on available short-circuit current, protective device clearing time and other applicable one-line diagram information.
   b. Calculate the Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm^2) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   c. Identify the Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   d. Identify the current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   e. Establish the Flash Protection Boundary (approach limit distance) as required by NFPA 70E for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

f. Provide equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.

g. Provide recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements

h. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

1.2 STUDY AND ANALYSIS SEQUENCE:

A. All studies and analysis specified herein shall be completed and submitted with electrical distribution equipment submittals to allow the Engineer to review submitted electrical distribution equipment for interrupting rating, coordination and arc flash related coordination.

1.3 QUALITY ASSURANCE:

A. The short circuit analysis/coordination study shall be performed by the Engineering Department of the electrical equipment supplied for the project or by a qualified engineering consultant approved in writing in advance by the Engineer.

1.4 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Four copies of the Short-Circuit Analysis including, but not limited to:

a. A printout of input data, calculated results and an explanation of how to interpret the data.

b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.

c. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X over R ratio of that fault current.

d. A table of specified equipment short-circuit ratings versus calculated short-circuit current values with notations of locations where are specified equipment short-circuit ratings are less or greater than required at the point of application.

e. An analysis of the results in which any overrating or inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.

2. Four copies of the Protective Device Coordination Study including, but not limited to:

a. Time-current characteristic curve drawings on log-log printouts which illustrate:

1) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.

2) The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.

3) The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.

b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.

c. An analysis of the results in which any inadequacies related to selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.

3. Four copies of the Emergency Power System Selective Coordination Study including, but not limited to:

a. Time-current characteristic curve drawings on log-log printouts which illustrate:

1) Compliance of the provided overcurrent protective devices with the specified selective coordination requirements.

2) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.

b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.

c. An analysis of the results in which any inadequacies related to the specified selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.

4. Four copies of the arc-flash & electrical hazard analysis including, but not limited to:

a. Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm^2) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

b. Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

c. Current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

d. The Flash Protection Boundary (approach limit distance) as required by NFPA 70 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

e. Equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.

f. Recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements

5. Cut sheets and submittal information on the Arc Flash warning labels being provided.

6. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

PART 2 - PRODUCTS

2.1 ARC FLASH WARNING LABELS:

A. Labels: Seton Write-On Arc Flash Warning Labels or an approved equal labels with NEC and OSHA required warning information and with Arc Flash Hazard Category, minimum Personal Protection Equipment (PPE) required and Minimum Arc Rating (cal/cm^2) clearly indicated.

PART 3 - EXECUTION

3.1 PROTECTIVE DEVICE SELECTION AND SETTING:

A. Settings and Selection: Prior to project Substantial Completion, the Contractor shall set all relays, overcurrent devices and ground fault protection devices and confirm selection of fuse overcurrent devices as follows:

1. Relays: Reset all adjustable relay settings from the factory default settings to the settings recommended in the studies specified in this section.

2. Circuit Breakers: Reset all adjustable trip settings from the factory default settings to the settings recommended in the studies specified in this section.

3. Ground Fault Protection Devices: Reset all adjustable device settings from the factory default settings to the settings recommended in the studies specified in this section.

4. Fuses: Confirm that fuse types installed on the project are as recommended in the studies specified in this section.

B. Certification: Prior to project Substantial Completion, the Contractor shall submit 4 signed copies of a document certifying that the Contractor has completed the settings and selection scope specified in Paragraph 3.1 A. to the Engineer.

3.2 AVAILABLE FAULT CURRENT LABEL:

A. Building Service entrance equipment shall be provided with a permanently affixed label listing the maximum available fault current at the time of installation and the date the fault current calculation was performed, per NEC 110.24. The label shall be 2” x 3” in size and shall be blue lettering on a contrasting background.

3.3 ARC FLASH WARNING LABELS:

A. Installation: Arc Flash warning labels shall be securely affixed to each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch in a readily visible location in accordance with NEC and OSHA requirements. The actual calculated Minimum Arc Rating (cal/cm^2) for that individual piece of equipment along with the associated Arc Flash Hazard Category and minimum Personal Protection Equipment (PPE) required shall be clearly indicated on each warning label

END OF SECTION 26 05 73

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SECTION 26 22 00 - LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide low voltage transformer work as shown, scheduled, indicated and as specified.

B. Types: The types of low voltage transformers required for the project include, but are not limited to,

1. Dry- Type General Purpose Transformers.
2. K-Factor Rated Dry-Type Transformers.
3. Dry-Type Harmonic Mitigating Transformers.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested and installed in compliance with the following standards:

1. NEMA ST 1 - Specialty Transformers.
2. ANSI/NEMA ST 20 - Dry Type Transformers for General Applications.
3. ANSI C33.4 – Specialty Transformers.
4. ANSI C89.2 – Dry-Type Transformers for General Applications.
5. ANSI/UL 506 – UL Standard for Safety Specialty Transformers.
6. UL 758 – Standard for Appliance Wiring Material.
7. NEMA TP-1 and EPA Energy Star compliant.

B. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

C. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

D. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1.4 QUALITY ASSURANCE:

A. Listing and Labeling: Provide transformers specified in this Section that are listed by Underwriters Laboratories (UL), certified by CSA, bear the EPA ENERGY STAR logo. Transformers shall meet relevant NEMA, UL, CSA, NFPA, EPA Energy Star Program.

B. Characteristics: Transformer, with characteristics and options specified, must deliver the energy savings required under the EPA ENERGY STAR program and bear the EPA ENERGY STAR logo.

C. Minimum Linear Load Efficiency: NEMA TP-1 and EPA ENERGY STAR compliant; 97.5 percent for 30 kVA, 97.7 percent for 45kVA, 98.0 percent for 75 kVA, 98.2 percent for 112.5kVA, 98.3 percent for 150 kVA, 98.5 percent for 225 kVA, 98.6 percent for 300 kVA, 98.7 percent for 500 kVA.

D. Non-linear Load Efficiency: Greater than 98 percent for all transformers 45kVA and above, greater than 97 percent for transformers 30kVA and smaller. Load per section “Factory Test Reports” above.

E. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Dry- Type General Purpose and K-Factor Rated Dry-Type Transformers.

a. General Electric Company.

b. Sola/Hevi-Duty Electric Corporation.

c. Square D Company.

d. Cuttler Hammer - Eaton.

e. Siemens.

f. Power Smith.

F. Energy Star: Manufacturer must be a US Environmental Protection Agency (EPA) ENERGY STAR Partner.

G. UL Label: All transformers shall be UL-labeled.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Include data on features, components, ratings and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

a. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics.

b. No load core loss, full load winding conductor loss, full load losses, efficiency at 25 percent, 50 percent, 75 percent and 100 percent rated loads, percent regulation with 80 percent and 100 percent power factor loads, sound level, tap configurations, insulation system type and rated temperature rise.

2. Cut sheets of the transformers with load ratings, sound ratings, and all associated accessories clearly indicated.

3. Include outline and support point dimensions of enclosures and accessories; unit weight; voltage; kVA; impedance ratings and characteristics; loss data; efficiency at 25, 50, 75 and 100% rated load; sound level; tap configurations; insulation system type, and rated temperature rise.

4. Additional information as required in Section 26 00 01, “Electrical General Provisions”.
5. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.
6. Product Certificates: Signed by manufacturer of transformers certifying that the products furnished comply with requirements, including harmonic performance guarantee.
7. Factory Test Reports: Base data for electrical characteristics on actual laboratory tests of typical transformers for harmonic performance and energy efficiency. Testing to be conducted using three (3) single-phase 120V nonlinear load banks with personal computer harmonic profile (100 percent current THD) at 35 percent or more of transformer nameplate load level. Test results to be submitted at time of quotation to include transformer efficiency, change in voltage THD between transformer primary and secondary terminals, ratio of 3rd harmonic current in primary delta current profile compared to that in secondary phase current.
8. Copies of manufacturer’s design and routine factory tests required by referenced standards, including results of zero sequence impedance and reactance tests.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Transport, handle, store and protect products.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle transformers carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged transformers shall be rejected and not be installed on project.

E. Store transformers in a clean and dry space and protect from weather. Do not stack transformers.

F. Apply temporary heat according to manufacturer’s written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

G. Transformers shall not be used as work tables, scaffolds or ladders.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: Except as otherwise indicated, provide transformer manufacturer's standard materials and components as indicated by his published product information, designed and constructed as recommended by the manufacturer, and as required for a complete installation.

2.2 DRY TYPE GENERAL PURPOSE TRANSFORMERS:

A. General:

1. Indoor transformers shall be dry type, 2-winding transformers, voltage, phase and kVA rated as shown, noted or scheduled. Transformers shall be designed for 60-hertz operation, self-cooled per NEMA Class AA and shall have manufacturer's standard impedance.
2. Primary winding of 3-phase standard transformers shall be delta-connected. Secondary windings of 3-phase transformers shall be wye or as required to cancel zero sequence current flux for phase cancellation type, with the common neutral brought out. Transformer primary and secondary voltages shall be as shown on the Drawings.
3. Suppression transformers shall have the primary and secondary coils physically separated.

B. Construction:

1. Transformer core shall be of a common core construction using cold rolled, oriented, high permeability silicon steel, formed as a coil. Windings shall be copper or electrical grade aluminum individual windings terminated with tin-plated or silver-plated copper bars or wire electrically welded to the ends of the windings. Foil windings shall not be acceptable.
2. Transformer coils shall be vacuum pressure impregnated (VPI) with non-hydroscopic, thermosetting varnish and shall have a final wrap of electrical insulating material designed to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable. The core and coil shall be completely isolated from the enclosure by means of vibration absorbing mounts.
3. All ventilating openings shall be of the baffled type. Ventilated dry-type transformers installed in sprinklered space shall have rain shields on all openings.
4. The base of the transformer shall be constructed of heavy gauge steel. The transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished with baked enamel.

C. Taps: Transformers shall have taps as follows:

KVA Rating	Taps
0.25 to 2 kVA, single phase	No taps
3-15 kVA, single phase	Ttwo 2.5% taps below normal voltage
25-100 kVA, single phase	Six 2-1/2% taps, two above and four below normal voltage
167-250kVA, single phase	Four 2-1/2% taps, two above and two below normal voltage
9-15 kVA, three phase	Two 2.5% taps below normal
30-300 kVA, three phase	Six 2-1/2% taps, two above and four below normal voltage
500 kVA, three phase	Four 2-1/2% taps, two above and two below normal voltage

D. Temperature Rating: Transformers shall utilize an insulation system that has been properly temperature classified and approved by UL and shall have temperature ratings as follows. Energy saving temperature rise, where specified, shall be obtained by increasing the transformer conductor size and shall not employ larger air ducts or cooling aids to lower the resistance temperature rise. The maximum top of case temperature shall not exceed 35°F (energy saving design) rise above ambient.

KVA Rating	Temperature Rating
0.25 to 2 kVA	Maximum winding temperature rise of 80°C with an insulation system temperature classification of 155°C
3-9 kVA	Maximum winding temperature rise of 115°C with an insulation system temperature classification of 185°C
15 kVA and above	Maximum winding temperature rise of 150°C with an insulation system temperature classification of 220°C.

E. Load Rating:

1. Transformers shall be capable of operating at 100% of nameplate rating continuously while in an ambient temperature not exceeding 40°C.

2. Transformers 5 kVA and larger shall be capable of meeting the daily overload requirements of IEEE - ANSI Standard C57.12.

F. Vibration Isolation: Each transformer core and coil shall be mounted in the transformer enclosure on rubber vibration isolators. Vibration isolators shall limit the transmission of sound from the 120 Hz harmonic to 10% of its unisolated level, and shall certified as such on the Shop Drawings.

G. Grounding: The core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.

H. Sound Rating: The transformer shall have sound levels equal to or lower than those ratings established in the latest revision of NEMA ST-20 and as shown in the following table. Sound ratings shall be measured per NEMA ST-20.

KVA (600 Volt Class)	Transformer Rating Maximum Sound Level Decibels Per NEMA ST-20
0-09	40
10-50	45
51-150	50
151-300	55
301-500	60

I. Testing:

1. The manufacturer shall have thoroughly tested each transformer for proper operation before shipment.
2. The manufacturer shall have performed the following additional tests on units identical to the design type being supplied. Furnish proof-of-performance of these tests in the form of test data sheets upon request.
   a. Sound levels.
   b. Temperature rise tests.
   c. Full-load core and winding losses.
   d. Percent regulation with 80 and 100% power factor load.
   e. Percent impedance.
   f. Exciting current.
   g. Insulation resistance.
   h. Efficiency at 1/4, 1/2, 3/4, and full load.
   i. Noise attenuation on suppression transformers.

J. Shield: Provide an electrostatic shield between the transformer primary and secondary to attenuate source side line interference for transformers indicated to be shielded and for all transformers with a K-factor rating greater than 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION OF TRANSFORMERS:

A. General: Install transformers as indicated in accordance with the applicable requirements of the NEC and the National Electrical Contractor's Association "Standard of Installation". Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Manufacturer's Recommendations: All installation shall be in accordance with manufacturer's published recommendations.

C. Conduit Connections: All conduit directly connected to transformer enclosures shall be flexible steel conduit extending for a minimum of 24 inches from transformer enclosure as measured along the conduit center line. Run a bonding jumper, sized per NEC Table 250-95, on outside of flexible conduit.

D. Cable Connections: Make transformer cable connections with compression-type lugs suitable for termination of 75 degrees C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75 degrees C.

E. Housekeeping Pads: All floor standing transformers shall be provided with a nominal reinforced concrete housekeeping pad. Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for additional requirements.

F. Transformer Isolation: Install floor-mounted transformers on concrete housekeeping pads with vibration isolating pads suitable for isolating the transformer noise from the building

structure in accordance with Section 26 05 01, "Electrical Basic Materials and Methods". Maintain a minimum of six (6) inches free air space between enclosure and walls.

1. Install transformer plumb and level.
2. For floor and trapeze transformer installations, use one pad type Korfund Elasto-Grip, waffle at each corner of the transformer, sized for load of 50 pounds per square inch.
3. For wall hung transformer installations (15kVA and less), use spring type Korfund Series P. Provide sound pads at each corner of the transformer sized for ½ inch deflection. Securely anchor wall-mounting brackets to wall to provide adequate support.

G. Suspended Transformers: Suspend transformers (45kVA and less) from structure by means of trapeze hangers constructed of ½ inch galvanized all-thread rods and metal framing channels. Make double-nut connections between rods and channels. Locate transformers to provide adequate ventilation and accessibility.

H. Identification: Refer to Section 26 05 53, “Identifications for Electrical Systems”, for transformer identification.

3.2 TESTING:

A. Pre-Energization Check: Check for damage and tighten connections prior to energizing transformer. Verify removal of coil shipping anchor bolts before transformer is energized.

B. Insulation Tests: Prior to energization, check transformer windings for continuity. Test the insulation resistance from primary phase winding to winding, primary winding to secondary winding, secondary phase winding to winding, and from each winding to ground. Tests shall be made with a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volts dc with readings taken after 30 and 60 seconds of operation at Megger slip speed. Transformers which do not meet or exceed manufacturers winding insulation resistance specifications shall be replaced and the new transformer shall be tested, until an acceptable resistance is obtained.

C. Winding Current: During initial no-load energization, check current in each primary winding.

D. Tap Settings: Measure and record load current and voltage of transformers while loaded to verify proper transformer tap setting. Select the appropriate tap setting on transformer so that the actual secondary voltage is + 1/2 of a tap span at full load.

E. Test Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Reports shall include transformer tested, date and time of tests, serial number, tap setting, input and output voltages, primary and secondary winding currents, insulation test results, manufacturers winding insulation resistance specifications, relative humidity, temperature, and weather conditions.

F. Notification: Notify Architect in writing of any deviation from manufacturer's pre-shipment test data.

END OF SECTION 26 22 00

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide panelboard and enclosure work, including cabinets, as shown, scheduled, indicated and as specified.

B. Types: The types of panelboards and enclosures required for the project include, but are not limited to, the following:

1. Power distribution panelboards.
2. Lighting and appliance panelboards.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1.	NEMA AB 1	Molded Case Circuit Breakers.
2.	NEMA PB 1	Panelboards.
3.	NEMA PB 1.1	Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
4.	W-P-115C	Panel, Power Distribution.
5.	W-C-375B	Circuit Breakers, Molded Case; Branch Circuit and Service.
6.	NFPA 70	National Electrical Code.
7.	UL 67	Standard for Panelboards.
8.	UL 489	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
9.	UL 943	Ground-Fault Circuit-Interrupters.
10.	UL 1283	Electromagnetic Interference Filters.
11.	UL 1449	Surge Protective Devices.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Cutler-Hammer - Eaton.
2. General Electric Company.

3. Schneider Electric - Square D Company.
4. Siemens.

B. UL Standards: Panelboards and enclosures shall conform to all applicable UL standards and shall be UL-labeled.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Panelboards and distribution panels shall not be submitted until they have been coordinated with the initial Short Circuit Analysis, Protective Device Coordination Study, Emergency Power System Selective Coordination Study and Arc Flash and Electrical Hazard Studies specified in Section 26 05 73 “Short Circuit Analysis/Coordination Study/Arc Flash Study”.
2. Cut sheets of the circuit breaker distribution panels and panelboards with construction, circuit breaker amperage and poles, interrupting ratings, and quantities clearly listed, and with bus amperage, voltage, phase and wires, integrated equipment ratings and all associated accessories clearly indicated.
3. Equipment arrangement must include panelboard schedules. Panelboard schedules must be identical to the schedules in the project documents unless there is a technical reason for a deviation. Reasons for any deviation shall be included in the Submittal.
4. Include dimensioned drawings of distribution panels, panelboards and enclosures. Submit, if requested, transparencies of circuit breaker characteristics with unlatch times.
5. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver distribution panels and panelboards in factory-fabricated water-resistant wrapping.

B. Handle distribution panels and panelboards carefully to avoid damage to material component, enclosure and finish.

C. Store distribution panels and panelboards in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: Lighting and appliance panelboards shall be dead front safety type equipped with molded case circuit breakers as shown and scheduled. Load center panels are not acceptable. Power distribution panelboards shall be dead front type equipped with molded case circuit breakers as shown and scheduled.

B. Busing Assembly: Panelboard and power distribution panel board busing shall be tin or silver-plated 98% conductivity copper. Bus structure and mains shall have ratings as shown and scheduled and shall be phase sequence construction. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or busbar not to exceed 65°C rise above 40°C ambient. Heat rise test shall be conducted in accordance with UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All

bus joints shall be bolted with medium carbon steel, zinc or cadmium plated hardware equipped with conical lock washers and torqued to the manufacturer's recommended settings (typically ASTM standards). All multi-section panelboards shall be connected with copper cable, with an ampacity meeting or exceeding the main bus ampacity.

C. Neutral Buses: Furnish an isolated full-size neutral bus with the same ampacity rating and material as the phase busses, insulated where noted, with lugs for connecting main and circuit neutral conductors in all distribution panels and panelboards where the neutral is present. All panels serve by K-rated or phase cancellation transformers shall have a 200% rated neutral.

D. Ground Buses: Furnish a bare uninsulated or an isolated, where noted, 1 inch x 1/4 inch tin-plated copper ground bus inside each distribution panel and panelboard enclosure with lugs for connecting main and circuit ground conductors.

E. Molded Case Panelboard Circuit Breakers:

1. Panelboard circuit breakers shall be of the molded case, thermal magnetic type equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Circuit breakers shall bolt in to the main bus for 480/277 volt panels (except Square D I-line panels which may have plug-in breakers) and bolt on to the main bus for 208/120 volt panels. All 2 and 3-pole breakers shall have common trips.

2. All single-pole and multi-pole panelboard circuit breakers shall be either ambient or case-compensated (calibrated 40°C) thermal-magnetic type breakers, with inverse time delay on overloads and instantaneous magnetic trip on short circuits. All multiple-pole breakers shall be common trip. Twin, tandem and half-size single-pole breakers and breaker tie handles are **not** acceptable.

3. Panelboard circuit breakers shall employ quick-make, toggle mechanism for manual operation, as well as automatic operation. Breakers shall have provisions for manually testing the tripping mechanism with the breaker removed from the panel. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual "on" and "off" positions.

4. Panelboard circuit breakers used as switches in 120 volt and 277 volt fluorescent lighting circuits, the circuit breakers shall be approved for such switching duty and shall be marked "SWD".

5. Provide panelboard circuit breakers with interrupting ratings which equal or exceed the preliminary calculated short circuit current indicated on the Drawings and the calculated short circuit current indicated in the initial Short Circuit Analysis specified in Section 26 05 73 “Short Circuit Analysis/Coordination Study/Arc Flash Study” but in no case less than the following minimum RMS symmetrical amperes:

Voltage (volts)	Interrupting Capacity
120/208	10,000 AIC
277/480	65,000 AIC

6. Fully Rated Panelboard Circuit Breakers: All panelboard circuit breakers shall be fully rated to interrupt the short circuit current available at the circuit breaker. Series breaker rating are not acceptable.
7. Ground fault interrupter (GFI) circuit breakers, where shown, shall be 5 ma ground fault trip and shall include a TEST button.

F. Molded Case Distribution Panel Circuit Breakers:

1. Distribution panel circuit breakers shall be of the molded case, thermal magnetic type equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Circuit breakers shall bolt in to the main bus (except Square D I-line panels which may have plug-in breakers). All 2 and 3-pole breakers shall have common trips.
2. Distribution panel circuit breakers shall be equipped with solid-state programmable trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. The solid-state electronic programmable trip device shall have the following features and tripping functions.
   a. Adjustable current setting.
   b. Adjustable long-time delay.
   c. Adjustable instantaneous pick-up.
   d. Adjustable short time delay.
   e. Adjustable short time pick-up.
   f. Adjustable ground fault delay
   g. Adjustable ground fault pick-up
3. Provide distribution panel circuit breakers with interrupting ratings which equal or exceed the preliminary calculated short circuit current indicated on the Drawings and the calculated short circuit current indicated in the initial Short Circuit Analysis specified in Section 26 05 73 “Short Circuit Analysis/Coordination Study/Arc Flash Study” but in no case less than the interrupting rating shown on the drawings.
4. Distribution panel circuit breakers shall be equipped with the following accessories as noted on the Drawings or required:
   a. Shunt Trip Device: 120 volts, AC.
   b. Auxiliary Switch: 120 volts, AC.
   c. Alarm Switch: 120 volts, AC.
   d. Electrical Operator: 120 volts, AC.
   e. Handle Lock: Provisions for padlocking.
5. Circuit Breaker Coordination: Circuit breaker types shall be selected and circuit breaker frame sizes shall be increased from the minimum frame sizes shown on the Drawings as required to provide the selective coordination for the electrical distribution specified in

Section 26 05 73 “Short Circuit Analysis/Coordination Study/Arc Flash Study to be provided with circuit breaker products supplied for the project.

G. Lugs: Distribution panels and panelboards shall be provided with main lugs, main overcurrent devices, and feed-thru lugs as noted on the Drawings. Lugs shall be suitable for use with the cable size and material installed. Panel wireways shall provide adequate space for wiring to all lugs.

H. Spaces: Where space for future breakers is shown, panelboard enclosure shall include removable blank panels or knockouts to allow installation of future breakers and panelboard busing shall be complete, including all required connectors.

I. Integrated Equipment Rating: Each distribution panel and panelboard, as a complete unit, shall have short circuit bracing and a short-circuit rating equal to the interrupting rating of the weakest overcurrent device installed in the distribution panel or panelboard which shall equal or exceed the preliminary calculated short circuit current indicated on the Drawings and the calculated short circuit current indicated in the initial Short Circuit Analysis specified in Section 26 05 73 “Short Circuit Analysis/Coordination Study/Arc Flash Study”. Such ratings shall have been established by tests on similar panelboards with the circuit breakers installed.

J. Short Circuit Bracing: Distribution panel and panelboard bussing shall have short circuit bracing which shall equal or exceed the preliminary calculated short circuit current indicated on the Drawings and the calculated short circuit current indicated in the initial Short Circuit Analysis specified in Section 26 05 73 “Short Circuit Analysis/Coordination Study/Arc Flash Study”. This rating shall be clearly indicated on the distribution panel or panelboard nameplate.

K. Surge Protection Devices (SPDs): All distribution panels and panelboards shall have factory installed integral surge protection devices with overcurrent protection where shown, scheduled or noted on the drawings. SPDs shall be provided with the following features:

1. SPD shall be fused with blown fuse indicators.
2. SPD shall provide L-L, L-N, L-G, N-G protection modes.
3. SPD shall be listed to UL 1449 Fourth Edition revision 2014. The unit shall also be listed to UL 96 as a secondary Surge Arrestor. Approved as a Transient Voltage Surge Suppressor and UL 1283 Listed as an Electromagnetic Interference Filter.
4. SPD shall be UL labeled with 20 kA nominal discharge current test (I-n).
5. SPD shall be equipped with surge counter.
6. SPD shall be equipped with dry contact for remote monitoring.
7. SPD shall be equipped with diagnostics.
8. SPD shall provide noise rejection (-20 to -40db @ 5K-10MHZ).
9. Surge Protection for Distribution Panel Locations (277/480V, 3 phase, 4 wire)
    a. SPD shall have a minimum surge current rating of 80kA per protection mode and 160kA per phase.
    b. SPD shall be life cycle tested to survive 6,000 IEEE Category C3 impulses in each protection mode, with less than 10% degradation.
10. Surge Protection for Distribution Panel Locations (120/208V, 3 phase, 4 wire)

a. SPD shall have a minimum surge current rating of 80kA per protection mode and 160kA per phase.

b. SPD shall be life cycle tested to survive 6,000 IEEE Category C3 impulses in each protection mode, with less than 10% degradation.

11. Surge Protection for Panelboard Locations (277/480V, 3 phase, 4 wire)

a. SPD shall have minimum surge current rating of 65kA per protection mode and 130kA per phase.

b. SPD shall be life cycle tested to survive 6,000 IEEE Category C3 impulses in each protection mode, with less than 10% degradation.

12. Surge Protection for Panelboard Locations (120/208V, 3 phase, 4 wire)

a. SPD shall have minimum surge current rating of 65kA per protection mode and 130kA per phase.

b. SPD shall be life cycle tested to survive 6,000 IEEE Category C3 impulses in each protection mode, with less than 10% degradation.

13. Refer to Section 26 43 13 “Transient Voltage Surge Protection Devices” for additional requirements.

L. Panelboard Enclosures: Panelboard enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Panelboard enclosures shall be NEMA Type 1 surface or flush mounted as shown, scheduled or noted for indoor locations and NEMA 3R for outdoor locations, minimum 16 gauge thickness, minimum 20" width, with multiple knockouts, unless shown, scheduled or noted otherwise. Panelboard fronts shall be full-height hinged door-in-door front covers with an interior access door hinged to the main front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with fastening, concealed on flush mounted panelboards, on the non-hinged side. Provide flush spring latch and keyed locks for all panelboard access doors. All distribution panel and panelboard locks shall be keyed alike. Provide an interior circuit directory frame, card and clear plastic covering inside the interior access door for all lighting and appliance panelboards. Door and cover trim shall be painted with manufacturers standard gray enamel finish over a rust inhibitor. Trim on flush mounted panels shall have concealed fasteners. Covers for panelboards installed in laundries and kitchens shall be stainless steel. Enclosures shall be fabricated by the same manufacturer as panelboards to be enclosed. Multi-section panelboards shall have separate covers and trims. Multi-section panel cans shall be installed side by side with covers butted together.

M. Distribution Panel Enclosures: Distribution panel enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Distribution panel enclosures shall be NEMA 1 surface or flush mounted as shown, scheduled or noted for indoor locations and NEMA 3R for outdoor locations. The distribution panel interior assembly shall be dead front with panel front removed. Main lugs or main circuit breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Interior surface distribution panels shall have full height front covers full height hinged to the distribution panel back box with fastening on the non-hinged side. Interior flush and exterior distribution panel fronts shall be full-height

hinged door-in-door front covers with an interior access door hinged to the main front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with concealed fastening on the non-hinged side. Cabinet interior doors shall be equipped with a latch and tumbler type lock. Doors over 48" long shall be equipped with a three-point latch and vault lock. All distribution panel and panelboard locks shall be keyed alike. Cabinets shall be of sufficient size to allow a width of gutter to conform with Underwriters' Laboratories, Inc. Standards. Panel trim shall be full finish sheet steel finished with two coats of paint, the first being a prime coat and the second a finish coat of light gray lacquer. Covers for panelboards installed in laundries and kitchens shall be stainless steel.

N. Service Entrance Panelboards: Distribution panels and panelboards that serve as service entrance equipment shall be constructed to meet the requirements of UL 67. Any single service disconnect distribution panel or panelboard must have provisions such that, when the service disconnect is opened, no person in the field servicing the equipment load side can make accidental contact with live circuit parts. Barriers to protect against unintended contact shall be constructed in such a way that they are easily installable and removable without contacting or damaging bare or insulated live parts.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS AND ENCLOSURES:

A. General: Install distribution panels, panelboards and enclosures as shown, including electrical connections, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function. Clean the top, all sides and inside of the distribution panels and panelboards. All distribution panels and panelboards shall free from dust and debris at all times.

B. Coordination: Coordinate installation of distribution panels, panelboards and enclosures with cable and raceways installation work. Verify that wall thickness is adequate where recessed panels are shown.

C. Anchoring: Anchor enclosures firmly to walls and structural surfaces ensuring that they are permanently and mechanically secured. Install surface-mounted cabinets and panelboards with a minimum of four anchors. In wet and damp locations use hot dip galvanized steel channel supports to stand cabinets and panelboards one inch off wall. Install a plastic bushing in all conduits. Install cabinets, distribution panels and panelboards plumb.

D. Concrete Pads: Install each floor-mounted power distribution panelboard on a reinforced concrete housekeeping pad. The housekeeping pad shall extend 3" beyond the housing of the distribution panel, unless otherwise shown. Furnish the exact position of any block outs, dimensions, and location of the housekeeping pads in time to prevent delay of the concrete work. Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for additional requirements.

E. Directory Card: Type the enclosure's circuit directory card upon completion of work. Refer to Section 26 05 53, “Identification for Electrical Systems”, for additional requirements.

F. Circuit Arrangement: Branch circuit connections to 3-phase lighting and appliance panelboards shall be arranged such that when two or three circuits are run with a common

neutral, each circuit shall be connected to a different phase unless otherwise shown. At the completion of the electrical system this Contractor shall check each phase of all panels under full load and arrange so that all phases shall carry the same load as near as possible.

G. Spare Conduits: Stub three empty one inch (1") conduits to accessible location above ceiling out of each recessed panelboard.

3.2 CLEANING AND HOUSEKEEPING

A. Distribution panels and panelboards shall be thoroughly cleaned on the interior and exterior prior to being energized and shall be maintained in that condition after being energized.

B. Prior to energizing distribution panels and panelboards, thoroughly clean interior and exterior of distribution panels and panelboards. Remove all trash and debris, use a vacuum to pick up all dirt and dust and dry wiping bus bars, bracing, insulators, conductors, circuit breakers, enclosure framing and top, front and side covers with a clean white cloth to remove all dust, debris, dirt, oil and moisture.

C. Use a vacuum cleaner to remove debris, dust and dirt from outside and inside distribution panels and panelboards and then dry wipe the inside and outside of switchboards and other electrical equipment with a clean white cloth to remove all dust, oil and debris. Do not use a blower or compressed air to blow dust from distribution panels and panelboards. Do not use CRC spray or similar sprays for cleaning.

3.3 TESTING AND ENERGIZATION:

A. General: Contractor shall furnish all instruments, personnel and third-party testing required for distribution panel and panelboard testing and energization and shall submit of certified test results to the Architect Engineer for review.

B. Pre-Energization Checks: Prior to energization, Contractor shall check distribution panels and panelboards for continuity of circuits and for short circuits.

C. Construction Circuit Breaker Adjustment: Prior to energization and for the duration of construction, all adjustable distribution breaker current trip settings shall be set to their minimum current and time values and ground fault trip current setting and time delays shall be set to their minimum values. During construction, current trip settings shall be increased where the construction/startup loads exceed the minimum current trip settings.

A. Construction Completion Circuit Breaker Adjustment/Testing: Following completion of the construction work and prior to final acceptance testing, an independent third-party testing laboratory shall adjust all adjustable distribution panel breakers to trip and ground fault settings recommended in the coordination studyand test main and distribution circuit breaker tripping and ground fault protection, where provided, using current injection. Circuit breaker testing shall be per NETA, Section 7.6.1.2.2. Submit an electronic copy of certified setting and test results to Architect/Engineer for review. Test reports shall include switchboard tested, test results, data values, date and time of test, relative humidity, temperature and weather conditions. All test reports, data and results shall be recorded as part of these submittals and included in the O&M manuals.

B. Thermographic Testing: Refer to Section 26 01 25, "Electrical Testing", for thermographic testing.

3.4 IDENTIFICATION:

A. Identification: Refer to Section 26 05 53, “Identification for Electrical Systems”, for applicable painting, nameplates, and labeling requirements.

B. Conductor Identification: All distribution panel and panelboard branch circuit phase, neutral and ground conductors shall be labeled label with the circuit number associated with the conductor.

C. Conduit Identification: All conduits entering and exiting distribution panels and panelboards shall be clearly marked with the circuits contained in the conduit using a black permanent marker.

END OF SECTION 26 24 16

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SECTION 26 27 17 - EQUIPMENT WIRING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.02 DESCRIPTION OF WORK:

A. Work Included: The extent of electrical connections for equipment is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.

B. Types: The types of electrical connections required for the project include, but are not limited to, the following:

1. Motors and equipment power connections.
2. Kitchen equipment power connections.
3. Contractor and Owner-furnished equipment power connections.
4. Miscellaneous control power connections.
5. Other equipment requiring power connections.

C. Work of Other Sections:

1. Refer to Section 26 27 18, "Miscellaneous Electrical Controls and Control Wiring", for miscellaneous electrical controls and control wiring.
2. Refer to other Divisions of these Specifications for specific individual equipment electrical requirements.

1.03 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. AMP, Inc.
2. Burndy Corporation.
3. Erico Cadweld.
4. O. Z. Gedney - Emerson.
5. General Electric Company.
6. Ideal Industries, Inc.
7. Mac Products, Inc.
8. 3M (Minnesota Mining and Manufacturing Company).
9. Thomas & Betts Company.

B. UL Label: All products shall be UL-labeled to the maximum extent possible.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS:

A. General: For each electrical connection indicated, provide a complete assembly of materials, including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations.

B. Raceways: Refer to Section 26 05 33, "Electrical Raceways", and Section 26 05 34, "Electrical Boxes".

C. Cable, Wire, and Connectors: Refer to Section 26 05 19, "Low Voltage Conductors and Cables".

D. Motor Starters and Safety Switches: Refer to Section 26 29 13, "Enclosed Motor Controllers", and Section 26 28 18, "Enclosed Switches".

E. Terminals: Provide electrical terminals as instructed by the terminal manufacturer for the intended application.

PART 3 - EXECUTION

3.01 MOTOR AND EQUIPMENT POWER CONNECTIONS:

A. All power connections to motors and equipment furnished by other Divisions shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.

B. Refer to the Drawings, approved Shop Drawings and other applicable Divisions for required power connections to equipment and motors.

C. All motorized or electrically operated equipment will be set in place by the furnishing Division with all integrally mounted starters, controls and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers and disconnect switches which are furnished with their equipment but not integrally mounted.

D. This Division shall furnish, install, and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.

E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between motors, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the Division furnishing the Equipment.

F. Unless otherwise indicated or specified, motors 1/2 hp and smaller shall be 120 or 277 volt, single phase, and shall be furnished with integral thermal overload protection. Provide manual disconnect switches as required. Where motors are not furnished with integral thermal overload protection, provide manual or magnetic starters as required.

G. Unless otherwise indicated or specified, motors 3/4 hp size and larger shall be 3-phase.

H. Motors 3/4 hp through 50 hp shall be furnished with "across-the-line", full-voltage nonreversing (FVNR) magnetic starters, unless otherwise indicated or specified.

I. Motors 60 hp and larger shall be furnished with reduced voltage nonreversing (RVNR) magnetic starters of the type indicated.

J. Where starters require disconnect switches in the immediate vicinity, combination motor starters shall be used. Where starters are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.

3.02 KITCHEN EQUIPMENT POWER CONNECTIONS:

A. All power connections to kitchen equipment furnished by under other Divisions shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.

B. Refer to the Drawings, approved Shop Drawings and other applicable Divisions, for required power connections to equipment and motors.

C. All kitchen equipment will be set in place by the furnishing Division with all integrally mounted starters, controls and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers and disconnect switches which are furnished with their equipment but not integrally mounted.

D. This Division shall furnish, install and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.

E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between equipment, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the other Divisions.

F. All connections to kitchen equipment shall be weatherproof. All flexible connections shall be made using liquidtight flexible conduit. All boxes for hardwired connections shall be gasketed FS type. All starters and safety switches installed in the kitchen area shall have NEMA 4 stainless steel enclosures.

G. Where starters, disconnect switches, conduit boxes or other items are mounted directly on the equipment served, the mounting location shall not inhibit removal of any required service panels or interfere with any required access areas.

H. All receptacles mounted below counter height or in wet areas shall have weatherproof coverplates.

I. Plug types on cord connected equipment shall be coordinated with the receptacle to provide compatibility. Where the installed plug and receptacle are not compatible, then this contractor shall be responsible for changing either the plug or receptacle as required for compatibility.

J. All conduits shall terminate in conduit boxes on equipment where possible. A piece of liquidtight flexible conduit not less than 12" long, shall be connected between the conduit and the equipment. Where equipment is not provided with conduit boxes, terminate the conduit in a suitable manner at the equipment.

K. Outlets of various types have been shown at equipment locations, but no indications of exact locations or scope of work is intended on the accompanying Drawings. The Contractor shall determine the exact location of all items:

1. From the applicable Drawings and Specifications and Shop Drawings of other Divisions.
2. From the Contractors responsible for the equipment involved.
3. By actual measurements at the site.
4. From Other Divisions.
5. By direction from the Owner.

L. Prior to installation, coordinate power and control provisions for kitchen equipment with approved kitchen equipment shop drawings. Where power and control provisions are significantly different than those shown, notify the Engineer in writing of the requirements. Where minor modifications to provisions are required, they shall be made at no cost as a matter of job coordination.

3.03 CONTRACTOR AND OWNER-FURNISHED EQUIPMENT POWER CONNECTIONS:

A. All power connections to motors and equipment furnished by other Divisions or by Owner shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.

B. Refer to the Drawings, approved Shop Drawings, other applicable Divisions and Owner-furnished equipment drawings for required power connections to equipment and motors.

C. All motorized or electrically operated equipment will be set in place by the furnishing Division with all integrally mounted starters, controls, and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers, and disconnect switches which are furnished with their equipment but not integrally mounted.

D. This Division shall furnish, install, and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.

E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between equipment, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the Division furnishing the Equipment.

F. All connections to Contractor and Owner-furnished equipment shall be made in a suitable manner.

G. Plug types on cord connected equipment shall be coordinated with the receptacle to provide compatibility. Where the installed plug and receptacle are not compatible,

then this contractor shall be responsible for changing either the plug or receptacle as required for compatibility.

H. Where starters, disconnect switches, conduit boxes, or other items are mounted directly on the equipment served, the mounting location shall not inhibit removal of any required service panels or interfere with any required access areas.

I. All conduits shall terminate in conduit boxes on equipment where possible. A piece of flexible or liquidtight flexible conduit (Refer to Section 26 05 33, “Electrical Raceways”) not less than 12" long nor more than 24" long, shall be connected between the conduit and the equipment. Where equipment is not provided with conduit boxes, terminate the conduit in a suitable manner at the equipment.

J. Outlets of various types have been shown at equipment locations, but no indications of exact locations or scope of work is intended on the accompanying Drawings. The Contractor shall determine the exact location of all items:

1. From the applicable Drawings and Specifications and Shop Drawings of the Divisions furnishing the equipment.
2. From the Contractors responsible for the equipment involved.
3. By actual measurements at the site.
4. By direction from the Owner.

K. Prior to installation, coordinate power, rough-in and control provisions shown on the drawings for radiology equipment with the provisions shown on approved Shop Drawings for the furnished radiology equipment. Where the power, rough-in and control requirements are less than or equal to those shown, then modifications to power, rough-in and control provisions shown shall be made at no cost as a matter of job coordination. Where power and control requirements are in excess of those shown, notify the Engineer in writing of the requirements.

L. Prior to installation, coordinate power and control provisions for Contractor and Owner-furnished equipment with approved equipment shop drawings. Where power and control provisions are significantly different than those shown, notify the Engineer in writing of the requirements. Where minor modifications to provisions are required, they shall be made at no cost as a matter of job coordination.

3.04 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. General: Install electrical connections as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Conductors: Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.

C. Splice Insulation: Cover splices with electrical insulation equivalent to, or of a higher rating than, insulation on the conductors being spliced.

D. Appearance: Prepare cables and wires by properly cutting and stripping covering, jacket and insulation to ensure a uniform and neat appearance where cables and wires are terminated.

E. Routing: Trim cables and wires to be as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.

F. Polyvinyl Chloride (PVC) Coated Conduit: Provide PVC-coated rigid steel conduit and fittings where required for highly-corrosive atmospheres.

G. Flexible Conduit: Provide flexible conduit, minimum 18" for connection of lighting fixtures and other electrical equipment connections, where subject to movement and vibration.

H. Liquidtight Conduit: Provide liquidtight flexible conduit, minimum 18" for connection of all motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Subjected to water spray.
5. Subjected to dripping oil, grease, or water.
6. Kitchens.

I. Conduit Location: All horizontal runs of conduit (not strapped to walls) shall be above 8'high, with a vertical drop to equipment. Conduit blocking walk and service space will not be acceptable and will require relocation. Conduit on and adjacent to equipment shall be located to allow free access to all removable panels for equipment service.

J. Motor Connections: Where possible, terminate conduit in conduit boxes at motors. Where motors are not provided with conduit boxes, terminate the conduit in a suitable condulet, and make motor connections. All conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet.

K. Coordination: Coordinate installation of electrical connections for equipment with equipment installation work.

L. Identification: Refer to Section 26 05 53, "Identification for Electrical Systems", for identification of electrical power supply conductor terminations with markers approved as to type, color, letter, and marker size by the Architect. Affix markers at each point of termination, as close as possible to each point of connection.

END OF SECTION

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SECTION 26 27 18 - MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included:

1. This Division shall furnish miscellaneous 120 volt control power circuits and control wiring as required for systems and equipment furnished by this and other Divisions. This control power and control wiring shall be furnished by this Division for all systems and equipment and where shown on the Drawings or approved Shop Drawings by the Division furnishing the system or equipment.
2. In general, all starters and controllers for non 120 volt equipment and motors shall be furnished with control power transformers, and control power circuits will not be required. Where control power transformers are not furnished, then 120 volt control power circuits shall be furnished by this Division.
3. Miscellaneous Control Power and Control Wiring: Systems and devices requiring control power circuits and control wiring include, but are not limited to:
   a. Automatic temperature control systems control power.
   b. Water treatment systems.
   c. Domestic water pump, surge tank and domestic water system controls.
   d. Sprinkler alarms.
   e. Contractor-furnished equipment controls.
   f. Owner-furnished equipment.
   g. Landscape sprinkler systems.
   h. Lighting and power control relays.
   i. Emergency generator/automatic transfer switch controls, battery chargers and jacket water heaters.
   j. Remote annunciator, alarm panels, alarms and signaling devices/systems.
   k. Start/Stop stations where required for remote motor controllers.
   l. Additional control power, control wiring and safety devices as shown, specified, or required.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Relays:

a. Automatic Switch Company.

b. RussElectric, Inc.

c. Square D Company.

PART 2 - PRODUCTS

2.1 WIRING AND RACEWAYS:

A. Line Voltage Control Wiring: This wiring shall be as specified in Section 26 05 19, "Low Voltage Conductors and Cables".

B. Low Voltage Control Wiring: This wiring shall be as specified in Section 26 05 19, "Low Voltage Conductors and Cables", except that conductors shall consist of a multi-conductor jacketed cable whenever possible.

C. Raceways: Raceways for line voltage and low voltage control wiring shall be as specified in Section 26 05 33, "Electrical Raceways", and Section 26 05 34, "Electrical Boxes".

PART 3 - EXECUTION

3.1 INSTALLATION OF MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING:

A. General: Install miscellaneous electrical control devices as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Requirements:

1. Miscellaneous control power circuits shall be obtained from spare breakers in building normal power panels. Where emergency system control power is required, or control power circuit requirements are large or significantly greater than normal, notify the Engineer in writing of the requirements.

2. All control devices which are part of the Life Safety System and for equipment and devices served with emergency power shall have their control power derived from an emergency source.

3. Control wiring shown on the Drawings or specified in other Division 26 sections is not an inclusive listing of all control wiring required on the project. All required control wiring, unless noted otherwise herein, shall be furnished and installed by the Division 26 Contractor.

4. HVAC temperature control wiring is specified and provided under Division 23 and 25 and is included in the Work of this Division. The only HVAC temperature control wiring and work included in the Work of this Division is providing 120 volt control power circuits for temperature controls (see Miscellaneous Control Power hereinabove) and coordination of Fire Alarm and Fireman's HVAC Override Panel connections to the temperature control system.

C. Conductors: Connect electrical conductors to miscellaneous electrical control devices in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.

D. Contactors and Relays: Install contactors and relays mounted in panelboards or individual enclosures as shown and be complete, including all control wiring and devices.

E. Lighting Controls: Install lighting controls as shown. Time program settings shall be as directed by the Architect.

F. Line and Low Voltage Control Wiring: Line and low voltage control wiring shall be installed in a suitable raceway.

G. Connections: Refer to Section 26 27 17, "Equipment Wiring", for connections to equipment.

H. Number Code/Color Code: Number/color code all control power and control power conductors appropriately for future identification and servicing. Refer to Section 26 05 53, “Identification for Electrical Systems” for additional requirements.

END OF SECTION 26 27 18

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide wiring device work as shown, scheduled, indicated, and as specified.

B. Types: The types of wiring devices required for the project include, but are not limited to, the following:

1. Receptacles.
2. Switches.
3. Wallbox dimmers.
4. Pushbuttons.
5. Wall plates.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. NEMA WD 1 General-purpose wiring devices.
2. NEMA WD 5 Specific-purpose wiring devices.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Bryant.
2. Harvey Hubbell, Inc.
3. Intermatic.
4. Leviton.
5. Lightolier, Inc.
6. Lutron, Inc.
7. Legrand (Pass and Seymour, Inc).
8. Prescolite.
9. Hubbell-Raco.
10. Taymac Corporation.

11. Wiremold Company.

B. UL Label: All wiring devices shall be UL-labeled.

1.5 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. Cut sheets of the receptacles, switches, wall box dimmers, and pushbuttons.
2. Cut sheets of the wall plates.
3. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver wiring devices individually wrapped in factory-fabricated containers.

B. Handle wiring devices carefully to avoid damage, breaking, and scoring.

C. Store in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 WIRING DEVICES:

A. General: Provide factory-fabricated wiring devices in the type, color, and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

B. Receptacles: Comply with NEMA Standard WD1 and as follows:

1. General Duty Decorator: Provide simplex or duplex commercial specification grade decorator type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

a. 20 amp, 125 volt grounded simplex NEMA #5-20R	Legrand (Pass & Seymour) #26361-*. Leviton #16351-*.
b. 15 amp, 125 volt grounded duplex NEMA #5-15R	Legrand (Pass & Seymour) #26252-*. Leviton #16252-*.
c. 20 amp, 125 volt grounded duplex NEMA #5-20R	Legrand (Pass & Seymour) #26352-*. Leviton #16352-*.
d. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault	Legrand (Pass & Seymour) #2095*L. Leviton #GFNT2-*.

current interrupter, back and side wired with indicator light.

e. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault current interrupter, back and side wired with indicator light hospital grade.
Legrand (Pass & Seymour) #2095HG*L.
Leviton #7899-HG*.

* Color designation, refer to Paragraph 2.3.

Wiring devices connected to emergency power circuits shall be as specified hereinabove except that wiring devices shall be red in color with coverplates color-matching other devices in the room.

2. General Duty Standard: Provide simplex or duplex commercial specification grade standard type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

a. 20 amp, 125 volt grounded simplex NEMA
Legrand (Pass & Seymour) #5361-*.
#5-20R
Leviton #5891-*.

b. 15 amp, 125 volt grounded duplex NEMA
Legrand (Pass & Seymour) #5252-*.
#5-15R
Leviton #BR15-*.

c. 20 amp, 125 volt grounded duplex NEMA
Legrand (Pass & Seymour) #5352-*.
#5-20R
Leviton #BR20-*.

d. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault current interrupter, back and side wired with indicator light.
Legrand (Pass & Seymour) #2095*L.
Leviton #8898-*.

e. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault current interrupter, back and side wired with indicator light hospital grade.
Legrand (Pass & Seymour) #2094HG*L.
Leviton #8898HG-*.

* Color designation, refer to Paragraph 2.3.

Wiring devices connected to emergency power circuits shall be as specified hereinabove except that wiring devices shall be red in color with coverplates color-matching other devices in the room.

3. Heavy-duty Simplex: Provide single heavy-duty type receptacles, with green hexagonal equipment ground screw, with metal mounting straps, back wiring, black molded phenolic compound, NEMA configuration as indicated.

a. 30 amp, 125 volt grounded single NEMA #5-30R	Hubbell #HBL9308 with #S703 stainless steel wall plate.
b. 30 amp, 250 volt, grounded, 3-wire, 2-pole NEMA #6-30R	Hubbell #HBL9330 with #S703 stainless steel wall plate.
c. 20 amp, 125/250 volt, grounded, 4-wire, 3-pole NEMA #14-20R	Hubbell #HBL8410 with #S7 stainless steel wall plate.
d. 30 amp, 125/250 volt, grounded, 4-wire, 3-pole NEMA #14-30R	Hubbell #HBL9430A with #S701 stainless steel wall plate.
e. 30 amp, 125/250 volt, grounded, locking, cast 4 wire, 3-pole NEMA #L14-30R (window washing receptacle)	Hubbell #HBL2710 with #7420 aluminum weatherproof wall plate.

4. Housekeeping Receptacles: Provide simplex specification grade twist-lock receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, NEMA configuration as indicated.

a. 20 amp, 125 volt grounded simplex NEMA #L5-20R	Leviton #2310*.

* Color designation, refer to Paragraph 2.3.

5. General Duty Clock Simplex: Provide single commercial specification grade type receptacles, 2-pole, 3-wire grounding, recessed to contain male plug and permit clock to cover outlet, with metal hook for supporting clock, ivory molded phenolic compound, side wired with screw type terminals, NEMA configuration as indicated.

a. 15 amp, 125 volt, grounded single NEMA #5-15R	Pass & Seymour #S3713-I. Leviton #688-I

6. Specific-use receptacles shall have volts, amps, poles, and NEMA configuration as noted on Drawings.

C. Switches: Comply with NEMA Standard WD1 and as follows:

1. Rocker: Provide commercial specification grade flush rocker switches, with mounting yoke insulated from mechanism, equipped with plaster ears, white switch rocker and side-wired screw terminals.

a. Single pole, 120/277 volt, 20 amp switch	Pass & Seymour #2621*. Leviton #5621-2*.
b. Three-way, 120/277 volt, 20 amp switch	Pass & Seymour #2623*. Leviton #5623-2*.
c. Four-way, 120/277 volt, 20 amp switch	Pass & Seymour #2624*. Leviton #5624-2*.
d. Single Pole, 120/277 volt, 20 amp switch, illuminated when on	Pass & Seymour #2629*. Leviton #5628-2*.
e. Single pole, double throw, momentary contact, center off, 120/277 volt, 15 amp switch	Leviton #5657-2*.

* Color designation, refer to Paragraph 2.3.

Wiring devices connected to emergency power circuits shall be as specified hereinabove except that wiring devices shall be red in color with coverplates color-matching other devices in the room.

2. Toggle: Provide commercial specification grade flush toggle switches, with mounting yoke insulated from mechanism, equipped with plaster ears, white switch handle, side-wired terminals, horsepower rated.

a. Single pole, 120/277 volt, 20 amp switch, key-operated	Pass & Seymour #PS20AC1-KL. Leviton #1221-2K*L.
b. Single pole, 120/277 volt, 20 amp switch	Pass & Seymour #20AC1-*. Leviton #CSB1-20*.
c. Three-way, 120/277 volt, 20 amp switch	Pass & Seymour #20AC3-*. Leviton #CSB3-20*.
d. Single pole, 120/277 volt, 20 amp switch, red pilot light	Pass & Seymour #20AC1-RPL. Leviton #1221-PLR.
e. Single pole, double throw, momentary contact, center off, 120/277 volt, 20 amp switch	Pass & Seymour #1091-*. Leviton #1285-*.

* Color designation, refer to Paragraph 2.3.

Wiring devices connected to emergency power circuits shall be as specified hereinabove except that wiring devices shall be red in color with coverplates color-matching other devices in the room.

D. Pushbutton: Emergency power off, single pole, 120 volt ac, 20 amp, momentary contact nonilluminated push button, red color cap and guard: Square D Company, Class 9001, KR2RH5 pushbutton, K25 flush stainless steel plate, KN805 legend plate, and K60 cover.

2.2 WIRING DEVICE ACCESSORIES:

A. Wall Plates: Provide switch, duplex outlet and telephone [screwless] wall plates, with single or multigang cutouts as indicated, [complete with metal screws for securing plates to devices.] [Screw heads shall be colored to match finish of plate.] Wall plates shall possess the following additional construction features:

1. Material and Finish:

a. Specification grade, smooth, high impact thermoplastic and Lexan for general duty receptacles, data receptacles, and switches. Pass & Seymour #RP series or approved equal. Jumbo plates are not acceptable.

b. Specification grade, Type 302, satin-finished stainless steel, 0.1" thick for heavy duty receptacles and kitchen receptacles.

c. Specification grade, weatherproof, coverplate, gasketed UV stabilized polycarbonate with hinged gasketed device cover, for exterior and wet area receptacles. Coverplates shall be NEMA 3R rated and shall be watertight when in use. Coverplates shall be as manufactured by Taymac Corporation, RACO, Intermatic or an approved equal.

d. Specification grade, smooth, high impact thermoplastic or Lexan for emergency power receptacles and switches.

2.3 WIRING DEVICE/COVERPLATE COLORS:

A. General: Provide general duty wiring devices and coverplates in colors as follows:

1. Painted Drywall: Provide white general use receptacles and switches and gray data receptacles with matching white thermoplastic coverplates in occupied areas and white Lexan coverplates in mechanical/electrical and maintenance areas.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Installer must examine the areas and conditions under which wiring devices and floor boxes are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING DEVICES:

A. General:

1. Install wiring devices where shown, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to ensure that products serve intended function. Delay installation of devices until wall construction and wiring is completed.

2. Special purpose switches and/or outlets not covered by the specifications, but noted on the Drawings shall be of the amperage, voltage rating, and NEMA configuration indicated. The switches and/or outlets shall be specification grade of the same quality as those specified.

3. When "**EQUIPMENT ONLY**" or "**JUNCTION BOX ONLY**" is indicated for equipment, it shall be the responsibility of the Electrical Subcontractor to obtain from the supplier, the complete data as related to the electrical portion of the equipment, including rough-ins, mounting height, type of outlet, items furnished by the supplier, etc. The Electrical Subcontractor shall be responsible for furnishing and installing all materials which are usually the Electrical Subcontractor's responsibility with the installation of the equipment.

4. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Construction Inspector.

B. Box Condition: Install receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, and similar matter.

C. Alignment: Install all wiring devices plumb and aligned in the plane of the wall, floor, or ceiling in which they are installed.

D. Switches and Dimmers: Install switches and wall box dimmers at a height as specified in Section 26 05 01, "Electrical Basic Materials and Methods", to switch center line, unless

otherwise noted on Drawings, on the strike side of doors as hung and in a uniform position so that the same direction will open and close the circuit throughout the project. Where shown near doors, install switches and dimmers not less than 2" and not more than 12" from door trim. Where more than one switch is in the same location, install switches in a multi-gang box with a single coverplate. Use toggle switches for motor disconnect switches only when installed in a ceiling plenum or in a mechanical, electrical, or telephone room.

E. Receptacles: Install receptacles vertically at a height as specified in Section 26 05 01, "Electrical Basic Materials and Methods", to receptacle center line above finished floor and horizontally at a height as specified in Section 26 05 01, "Electrical Basic Materials and Methods", to receptacle center line above counter tops unless shown or specified otherwise. Where splash backs occur above counters, mount devices horizontally at a height as specified in Section 26 05 01, "Electrical Basic Materials and Methods", to receptacle center line above splash backs. **Receptacles shall be installed with ground pin receiver down**. All devices shall be installed complete with coverplates. Use 20 ampere receptacle when only one receptacle is installed on a branch circuit**.**

F. Coverplates:

1. Install stainless steel coverplates on all heavy-duty receptacles and wiring devices located in kitchen areas. Coffee bars shall not be considered kitchen areas. Install weatherproof coverplates on all exterior and wet area receptacles. Refer to Paragraph 2.03 for additional requirements.
2. Multi-gang wall plates shall be used for each group of ganged devices. Mounting screws shall be installed for each device covered by the wall plate.
3. Wall plates for concealed work shall be flush against the finished wall, and shall completely cover the wall opening. Wall plates shall not be installed until all painting has been completed. Devices shall be protected by masking tape or other coverage until painting is complete. Any device with paint on it shall be replaced at no expense to the Owner. Jumbo plates are not acceptable.
4. Engrave and black paint fill text descriptions and branch circuit numbers on switch and receptacle coverplates where shown on the Drawings or specified herein.

G. Mounting Heights: Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for wiring device mounting heights.

3.3 PROTECTION OF WALL PLATES AND RECEPTACLES:

A. General: Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.4 IDENTIFICATION:

A. Refer to Section 26 05 53, "Identification for Electrical Systems", for wiring device identification requirements.

3.5 TESTING:

A. General: Prior to energization, check for continuity of circuits, for short circuits and check grounding connections. After energization, check wiring devices to demonstrate proper operation and receptacle polarization.

END OF SECTION 26 27 26

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SECTION 26 28 13 - LOW VOLTAGE VOLT FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: The extent of fuse work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.

B. Types: The types of fuses required for the project include, but are not limited to, the following:

1. 250 volt current-limiting fuses.
2. 600 volt current-limiting fuses.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. ANSI/UL 198E Class R Fuses.
2. ANSI/UL 198C Safety High-Interrupting-Capacity Fuses, Current Limiting Types.

B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/Engineer.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products produced by Eaton - Bussmann Manufacturing.

1. The Contractor shall base his proposal upon Eaton - Bussmann fuses. If the Contractor wishes to use fuses other than specified, and produced by one of the manufacturers listed below, written request shall be submitted to the Engineer for approval review as required in Section 26 00 01, “Electrical General Provisions”, under "Prior Approval", together with proof that the substituted fuses "are equal", and that all proposed fuses have been selected for proper fuse coordination with all components of the power system.
    a. Mersen/Ferraz Shawmut/Gould Fuses.
    b. Littlefuse.

B. Coordination: All fuses shall, to the maximum extent possible, be from the same manufacturer to facilitate positive selective coordination of protective devices.

1.5 SUBMITTALS:

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheet submittals shall be provided for all fuse types required for the project.
2. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Store fuses in a clean and dry space and protected from weather. When necessary to store outdoors, elevate materials well above grade and enclose with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 250/600 VOLT CURRENT-LIMITING FUSES:

A. General: Provide 200,000 amperes interrupting capacity (AIC) current-limiting fuses of the current ratings shown and with a voltage rating equal to or greater than the voltage at the point of application.

B. Types:

1. Fuses in circuits supplying individual motors, groups of motors or loads including motors, 600 amperes or less, shall be UL Class RK1 true dual-element, time-delay fuses, unless otherwise shown. Dual-element fuses must hold 500% of rated current for a minimum of 10 seconds and clear 20 times rated current in 0.01 seconds or less.
2. Fuses in circuits supplying individual motors, groups of motors or loads including motors, 601 to 4000 amperes, shall be UL Class L time-delay fuses, unless otherwise shown. Time delay fuses shall hold 500% of rated current for 4 seconds and clear 20 times rated current in 0.01 seconds or less.
3. Fuses in circuits supplying other than motor loads, 600 amperes or less, shall be UL Class RK1 true dual-element, time-delay fuses, unless otherwise shown. Dual-element fuses must hold 500% of rated current for a minimum of 10 seconds and clear 20 times rated current in 0.01 seconds or less.

2.2 SPARE FUSES:

A. General: Provide spare fuses in the amount of 10% of each type and size installed, but not less than three spares of a specific size and type. Deliver these spares to the Owner at the time of acceptance of the project. Fuses shall be neatly encased in a properly labeled steel enclosure with padlock provision, to be wall mounted as directed.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install fuses in fuse holders immediately prior to energization of the circuit in which the fuses are installed. Fuses shall not be installed and shipped with equipment.

B. Labels: Place fuse identification labels, showing fuse size and type installed, inside the cover of each switch or other location where fuses are installed.

END OF SECTION 26 28 13

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SECTION 26 28 18 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide safety and disconnect switch work as shown, scheduled, indicated, and as specified.

B. Types: The types of safety and disconnect switches required for the project include, but are not limited to, equipment disconnects and motor-circuit disconnects.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. Federal Spec. W-S-865 Switch, Box (Enclosed), Surface-Mounted.
2. NEMA KS 1 Enclosed Switches.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Cutler-Hammer - Eaton, Inc.
2. Eaton.
3. General Electric Company.
4. Siemens.
5. Square D Company.

B. UL-Label: Safety and disconnect switches must have Underwriters' Laboratories, Inc., approval and bear the UL label.

1.5 SUBMITTALS:

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheets of the safety and disconnect switches with ratings, voltage, poles, capacity, horsepower, short circuit rating, and all associated accessories clearly indicated.
2. Include dimensioned drawings of electrical safety and disconnect switches which have a rating of 100 amperes or larger, showing the accurately scaled switches, their layout, and relation to associated equipment.
3. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.

B. Handle switches carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.

C. Store switches in a clean and dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIAL:

A. General: Provide heavy-duty type, dead front, sheet steel-enclosed, surface-mounted safety switches of the type and size indicated. Safety switches shall be rated for the voltage of the circuit in which they are installed. Safety switches used as motor disconnects shall be horsepower rated for the motor served.

B. Switch Mechanism:

1. Safety switches shall be quick-make quick-break type with permanently attached arc suppressors and constructed such that switch blades are visible in the "OFF" position with the door open. The operating handle shall be an integral part of the box, not of the cover. Switch shall have provision to padlock in the "OFF" position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the "ON" position or closing of the switch mechanism when the switch door is open.

2. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel. All current-carrying parts shall be constructed of high conductivity copper with silver-plated switch contacts. Lugs shall be copper-plated or aluminum, suitable for copper or aluminum cable and front removable. Switch blades shall be copper.

C. Fusing: Provide fusible safety switches where indicated. Fuse clips shall be positive pressure rejection type fuse clips suitable for use with UL Class R fuses.

D. Neutral: Provide safety switches with number of switched poles as indicated. Where a neutral is present in the circuit, provide a solid neutral with the safety switch.

E. Enclosures:

1. All safety switches installed in indoor locations shall be NEMA 1 general purpose enclosures unless otherwise shown.

2. Safety switches installed in exterior locations or where exposed to outdoor conditions shall be NEMA 3R (water resistant) unless otherwise shown or specified.

3. Safety switches installed in wet areas in kitchens shall be NEMA 4 (stainless steel), unless otherwise shown.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Installer shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES:

A. General: Install safety and disconnect switches where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

B. Location: Provide safety switches where shown and at each motor which is out-of-sight-of or greater than 50' from the switch or panel from which the motor circuit is fed, unless another NEC complying disconnecting method is utilized.

C. Supports: Provide all safety and disconnect switches with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.

D. Disconnect Switches: Install disconnect switches used with motor-driven appliances, motors, and controllers within sight of the controller position unless otherwise indicated.

E. Coordination: Coordinate safety and disconnect switch installation work with electrical raceway and cable work as necessary for proper interface.

3.3 TESTING:

A. General: Prior to energization, check for continuity of circuits and for short circuits.

3.4 IDENTIFICATION:

A. Refer to Section 26 05 53, “Identification for Electrical Systems”, for applicable painting, nameplates, and labeling requirements.

END OF SECTION 26 28 18

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SECTION 26 32 13 - STANDBY GENERATOR SETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide standby engine-driven generator set work as shown, scheduled, indicated, and as specified.

B. Type: The type of standby engine-driven generator set required for the project include, but are not limited to, natural gas engine-driven generator sets.

1.3 STANDARDS:

A. Equipment shall comply with applicable sections of the latest edition of the following standards:

1. NEC.
2. NFPA 37 and NFPA 110.
3. IEEE.
4. NEMA.
5. ANSI.
6. TCEQ Requirements (EPA Tier Levels for Non-Road Engines) Latest effective requirements.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Caterpillar Tractor Company.
2. Cummins Power Generation/Onan Corporation.
3. MTU Detroit Diesel.
4. Kohler Company.
5. Generac Power Systems.

B. NEC and NFPA Compliance: Comply with applicable portions of the NEC (NFPA 70) including, but not limited to, emergency and standby power generation systems and with NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", and NFPA 110, "Emergency and Standby Power Systems".

C. IEEE Compliance: Comply with applicable Institute of Electrical and Electronics Engineers, Inc. (IEEE) standards pertaining to generator construction.

D. Emissions Compliance: The generator set engine shall comply with all applicable Regulations and Requirements for Beaumont, Texas and shall comply with all applicable EPA Tier Levels for Non-Road Engines that is currently in effect for the Beaumont, Texas area.

E. Testing:

1. The entire generator system shall be assembled on the factory test bed and shall be submitted to the full factory standard test to demonstrate automatic operation, start time, full capacity acceptance, regulation, motor starting capability and function of all system safeties, prior to shipping to the job site. System shall be tested at 0.8 pf. A strip chart recording shall be made of each unit to verify frequency, voltage transient, and output power.

2. The reporting form for the factory test shall be submitted to the Engineer for review with the Shop Drawings submittal and the Engineer shall be notified a minimum of one month prior to the factory test so that an Owner's Representative can witness the test.

F. Performance Tests: The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include:

1. Maximum power level.
2. Maximum motor starting capacity.
3. Structural soundness.
4. Torsigraph analysis per MIL-STD-705B, Method 504.2.
5. Fuel consumption.
6. Engine-alternator cooling airflow.
7. Transient response and steady state governing.
8. Alternator temperature rise per NEMA MG1-22.40.
9. Single step load pickup per NFPA 76A-822.
10. Harmonic analysis and voltage waveform deviation per MIL-STD-705B, Method 601.4.
11. Three-phase short circuit test for mechanical and electrical strength.

G. Manufacturer: The system shall be built, tested, and shipped by the manufacturer of the Standby Electric Power System, who has been engaged in the production of engine-alternator sets and associated controls for a minimum of 10 years, so there is one source of supply and responsibility.

H. Warranty: All equipment bearing a manufacturer's guarantee, such as electrical equipment, devices, components, and similar items, shall be construed to have a 5 year parts, travel, and labor guarantee to the Owner by the manufacturer. Any such equipment that proves

defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. A written description of the system operation (written the this specification format) with all exceptions and/or deviations clearly hi-lited or identified.
2. Completely identified and marked catalog cuts of all associated equipment and devices, with all non-applicable items crossed out, and applicable equipment or devices clearly hi-lited or identified.
3. A written description of the maximum "starting" and "running" kVAs and kWs of the system equipment (charts and graphs will not be acceptable).
4. A floor plan sketch complete with a dimensional description of the standby electric power system and associated equipment, locating the system equipment and accessories within the allotted space.
5. Interconnection wiring diagrams to indicate terminal connections between the remote alarm annunciator panel and the electric set.
6. Complete bill of material for all equipment.
7. Complete warranty information as specified.
8. A notarized letter from the system supplier certifying compliance with all requirements of this Specification.
9. Performance test as specified in Paragraph 1.4/E and F of this Section.
10. Additional information as required in Section 26 00 01.

1.6 STORAGE AND HANDLING:

A. The standby generator set(s) shall be stored at the factory until they must be shipped to the job site to prevent building construction delay.

B. The standby generator set(s) shall be crated and covered to protect it from damage during shipment and subsequent storage at the job site.

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR SETS:

A. General: Provide a new outdoor rated natural gas engine-driven generator set, complete with safety devices, main output breaker, weatherproof enclosure and vibration isolators. Installation shall be complete with all necessary fuel connections, natural gas fuel system with secondary gas pressure regulator, radiator cooling and engine exhaust from the building. Unit shall be capable of continuous standby service.

B. Design Basis: The standby generator set(s) specified and shown on the Drawings is based on **Generac SG350** generator and selected from data derived from manufacturer's engineering manuals.

C. System Capacity: The engine-generator set, as a unit, shall be rated for a continuous standby capacity of 350 kW and 438 kVA at 0.8-PF, with an output of 527 amperes while generating 480Y/277 volt, 3-phase, 4-wire, 60 Hz power, and with performance as specified herein.

1. A permanent magnet generator (PMG) or equal shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices. Alternator rating with PMG: With 1,560 motor starting kVA applied to the alternator, the maximum voltage dip shall be 30%, and comply with the performance requirements specified herein. **Motor starting kVA based on K0600124Y23 manufacturer alternator.**

D. Natural Gas Engine: Engine shall be an 8, 12, or 16 cylinder, 4 cycle, turbocharged/aftercooled or normally aspirated natural gas carburetor, natural gas engine, water-cooled with mounted water pump. Following items shall be included:

1. Valves: Intake and exhaust valves shall be heat-resisting alloy steel, free rotating. Exhaust valve seat inserts shall be replaceable.

2. Battery Charging: Belt-driven engine alternator; 24 volt negative ground 35 amp dc, with transistorized voltage regulator.

3. Governor: Hydraulic or electronic speed-sensing governor capable of isochronous frequency regulation from no load to full rated load. Speed droop shall be externally adjustable from isochronous to 5%.

4. Filters: Air cleaner and lube oil filters shall have replaceable elements.

5. Starting System: Remote 24 volt, 2-wire, negative ground, starting system, positive shift, gear engaging electric starter, cranking limiter.

6. Lubrication System: Forced feed gear design lube oil pump; full pressure lubrication to all bearings; dual, full flow oil filters; oil level indicator; low oil pressure shutdown; lube oil cooler; and oil pressure gauge.

7. Natural Gas Fuel System: Dry natural gas having a LHV of 905 BTU/CF at a delivery pressure of [5] psi. Engine shall have a natural gas carburetor and gas train with a secondary gas pressure regulator. Average fuel consumption at full load shall not exceed 4,140 CFH.

8. Cooling System: The cooling system shall be unit mounted radiator cooled, self-sealing prelubricated coolant pump; belt driven pusher fan with wire guard; thermostat temperature control; high coolant temperature shutdown; low coolant level shutdown; intercooler. The cooling system shall be tested for leaks. As soon as the system has been tested, it shall be filled with ethylene glycol rust inhibiting and antifreeze solution sufficient to protect the system to -10°F. Engine-driven pusher type cooling fan shall be sized to maintain safe operation at 122°F maximum ambient temperature. Airflow

restriction from static pressure at the radiator discharge shall not be more than 0.5" of water.

9. Emissions Compliance: The generator set engine shall comply with all applicable Regulations and Requirements for Beaumont, Texas and shall comply with all applicable EPA Tier Levels for Non-Road Engines that is currently in effect for the Sour Lake, Texas area at the time of installation.

E. Set Characteristics: Set manufacturer shall certify that reserve horsepower is available from the engine with all accessories operating in the ambient conditions hereinbelow. The diesel engine-generator set shall be capable of picking up 100% of nameplate kW and power factor, less applicable derating factors, in one step with the engine-generator set at operating temperature, in accordance with NFPA 110, Paragraph 5.13.2.6, and including the following constraints:

1. Ambient conditions of 50' altitude and an ambient temperature of -10 to 122°F.
2. The BMEP of a turbocharged engine producing rated generator capacity shall not exceed 306 psi for four cycle engines and 225 psi for two cycle engines.
3. The rpm of the engine shall not exceed 1800 rpm and the engine piston speed shall not exceed 2000'per minute.

F. Engine Protective Devices:

1. The engine protective devices shall provide automatic shutdown for overcrank, overspeed, high coolant temperature and low oil pressure. A low coolant level protective device shall be provided but shall alarm only and not initiate engine shutdown
2. The high coolant temperature and low oil pressure shall have pre-shutdown signals.
3. The overcrank alarm shall be the output of a solid-state cranking device preset at a 10 second cranking cycle and a 15 second rest cycle. If the engine fails to start on the third cranking cycle, the overcrank alarm shall sound and cranking shall stop. Unit shall be capable of repeating the above cranking cycle after the trouble has been cleared.

G. Generator: Generator shall be 4-pole, revolving field type, brushless, dynamically balanced, skewed laminated, two thirds pitch wound, rotating rectifier exciter, temperature compensated solid-state voltage regulator, open dripproof, single bearing, permanently aligned generator connected to engine with flexible disc coupling, including the following:

1. NEMA Class F or better insulation as defined by NEMA MG1.65.
2. Temperature rise at rated load within NEMA MG1-22.40 definition.
3. Double-sealed ball bearings, lubricated for life.
4. Direct-drive centrifugal blower cooling.
5. A 120 volt, single phase space heater shall be provided to prevent condensation in the generator.
6. AC output leads shall be brought out to field connection busbars accessible through removable plates in the generator output junction box.

7. The automatic voltage regulator shall be a solid state design and include overvoltage and undervoltage protection functions. The voltage regulator shall be equipped with 3-phase RMS sensing. The regulator shall control buildup of ac generator voltage to provide a linear rise and limit overshoot. Overvoltage protection shall sense the ac generator output voltage and in the event of regulator failure or loss of reference, shutdown regulator output on a sustained overvoltage of one second duration. Over excitation protection shall sense regulator output and shutdown regulator output if overloads exceed 10 seconds duration. Both overvoltage and over excitation protection shutdowns shall be latched, requiring generator set shutdown to reset.

8. The regulator shall include an under-frequency roll-off torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58-59 Hz. The torque-matching characteristic shall include differential rate of frequency change compensation to use maximum available engine torque and provide optimal transient load response. Regulators which use fixed volts per Hertz characteristics are not acceptable.

H. Generator Output Circuit Breaker(s): Generator set shall have 3 pole output circuit breaker(s) with solid state trip units as shown on the drawings. Breaker frame and trip ratings shall be as shown on the drawings. Breakers serving emergency and standby loads shall have breaker position indicating contacts. Breaker position indicating contacts shall be wired to initiate a generator control panel alarm when the breaker is open or tripped. Circuit breaker manufacturer and type for all breakers serving emergency and standby loads shall match the project electrical gear package to provide compatibility for selective coordination required by the NEC.

I. Engine/Generator Set Performance:

1. Frequency Regulation: Isochronous from no load to full rated load.

2. Voltage Regulation: Plus 2% no load to rated load; rheostat for _5% voltage adjustment.

3. Voltage Dip: Instantaneous voltage dip shall be less than 15% of rated voltage when full, 3-phase load and rated power factor is applied to the generator. Recovery to stable operation shall occur within 5 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant with _1% of rated voltage. All unit performance characteristics shall be verified using an oscilloscope.

4. Total Harmonic Distortion (THD): The sum of ac voltage waveform harmonies, from no load to full linear load shall not exceed 5% of the rated voltage (L-N, LL, L-L-L) and no single harmonic shall exceed 3% of rated voltage. Telephone Influence Factor (TIF) shall be less than 50 per NEMA MG1-22.43. Temperature rise at rated load and power factor shall be within NEMA MG1-22.40 definition.

5. Voltage Dip Performance: A light beam oscilloscope test for the specific generator set, by model and serial number shall be provided for the four step loads listed hereinbelow. Certified test results shall be reported via a strip chart recorder and submitted with generator factory test results.

   a. 0% to 25% kW load at 0.4 lagging PF.

   b. 0% to 50% kW load at 0.4 lagging PF.

c. 0% to 75% kW load at 0.4 lagging PF.

d. 0% to 100% kW load at 0.4 lagging PF.

J. Engine-Generator Instrument Panel: The instrument panel shall be mounted on vibration isolators and shall have dc controls, ac controls, and panel lighting. The top of the instrument panel shall not be more than 6'-6" above finished floor.

1. DC engine controls (2-wire, 24 volt system) including but are not limited to run-stop-automatic test-manual switch, remote start-stop terminals, oil pressure gauge, coolant temperature gauge, charge rate ammeter and running time hour meter.
2. Solid state engine monitoring system with monitors in accordance with NEC Section 700, NFPA 110 and local code requirements with lamps, audible alarm, lamp test switch, individual alarm contacts and a common alarm contact for:
    a. Overcrank shutdown
    b. Low coolant temperature warning
    c. Pre-warning for high engine temperature
    d. High engine temperature shutdown
    e. Pre-warning for low lube oil pressure
    f. Low lube oil pressure shutdown
    g. Overspeed shutdown
    h. Low coolant level warning
    i. Generator (EPS) supplying load.
    j. Generator control switch not in auto position warning
    k. High battery voltage warning
    l. Low cranking voltage warning
    m. Low battery voltage warning
    n. Battery charger failure
    o. Generator output breaker(s) open warning
3. Provide two dry auxiliary contacts one for common alarm and one for engine running to be monitored by the BAS.
4. AC output controls include, but are not limited to, an ac voltmeter; ac ammeter; voltmeter-ammeter phase selector with an "off" position; voltage adjusting rheostat; frequency meter; manual reset exciter circuit breaker and fine speed control potentiometer.
5. Two sets of double pole auxiliary contacts shall change state when engine starts; both sets shall be spare.

K. Accessories:

1. Remote Annunciator(s): Flush mounted remote annunciators shall be microprocessor based annunciator with network communication type, located as shown on the Drawings, and shall have audible and LED visual signal devices, powered by the electric set lead acid battery set, to provide a warning of derangement or alarm conditions in the electric set in compliance with the National Electrical Code Section 700, NFPA 110 level 1, 20 lamp and the requirements of these Specifications. The enclosure shall be constructed of sturdy sheet steel with white finish, and shall have removable front panel and adapter ring for flush mounting. The face of the front panel shall contain LED's (visual signals), and audible alarm, an alarm silence push button, and a LED test push button. The internal wiring, terminal block, and battery voltage sensors shall be accessible by removing the front panel of the enclosure. Remote annunciators shall indicate the following conditions:
    a. Visible and audible alarm for:
        1) Overcrank shutdown
        2) Low coolant temperature warning
        3) Pre-warning for high engine temperature
        4) High engine temperature shutdown
        5) Low lube oil pressure shutdown
        6) Overspeed shutdown
        7) Low coolant level warning
        8) Generator control switch not in auto position warning
        9) Low cranking voltage warning
        10) Low battery voltage warning
        11) Generator output breaker(s) open warning
        12) Generator power available
        13) Spare/Customer alarm
        14) Spare/Customer alarm
        15) Spare/Customer alarm
        16) Spare/Customer alarm
    b. Visible indicator for:
        1) Battery voltage okay.
2. Jacket-Water Heater: The engine shall have jacket-water heater(s) supplied by the manufacturer and powered from a "normal" branch circuit. The jacket-water heater shall be complete with a thermostat capable of maintaining a water temperature of 25°C, with an ambient temperature of 0°C. A water temperature alarm, consisting of a contact closed when the jacket water temperature is below 20°C, shall be supplied.

3. Exhaust System: Exhaust silencer(s) of the type, with side or end inlet as required shall be shipped pre-installed and piped on top of the generator enclosure. The exhaust silencer(s) shall be of chambered construction and shall provide maximum degree silencing, and shall be sized to assure proper operation without excessive back pressure when installed in the exhaust system. The exhaust silencer(s) shall be supplied with condensation drains, flexible exhaust tubing, wall thimbles and rain caps, as required.
4. Starting Batteries: Furnish and install fully charged 24 volt lead acid, impact resistant, storage batteries mounted on the unit or on a separate rack. Batteries shall have sufficient capacity for 60 seconds of continuous cranking per NFPA 99. Provide all required battery cables, connections, electrolyte and a battery hydrometer.
5. Solid-State Battery Float Charger: A suitable 120 volt automatic SCR voltage regulated battery charger with a maximum charge rate, as recommended by the manufacturer, but not less than 10 amperes shall be provided to maintain each set of batteries at full capacity during standby conditions The maximum charging time to bring the batteries up to full charge shall not exceed 12 hours. The charger shall be provided with a remote alarm contact to indicate a charger failure condition. An ammeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger shall be so designed that it will not be damaged during the engine cranking and shall be interlocked such that it is not damaged during generator set operation. The charger may be furnished as a separate item with necessary cables and leads.
6. Natural Gas Regulator/Piping: Each generator set shall be provided with a natural gas regulator sized to serve the generator set from a 5 psig natural gas supply and factory piped to the engine carburetor.
7. Vibration Isolation: Suitable aluminum housed, spring type vibration isolators be provided. Isolators shall be sized to properly support the generator set and to isolate 99% of the generators vibration from the supporting structure.
8. Skid Base: The entire packaged unit shall be mounted on a skid base of welded structural steel, of box type construction suitable for mounting on spring vibration isolators. A sloped drip pan shall be provided for containing engine fluid spills. Provisions for stub up of electrical and fuel connections shall be within the footprint of the generator set base rails.
9. Painting: The entire engine generator set shall have all exposed metal surfaces primed with a rust inhibiting primer and multiple finish coats of the manufacturer's standard machinery enamel finish.
10. Electrical Provisions:
    a. Compliance with NEC: Package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.
    b. Provide an internally mounted and wired electrical distribution panel to serve the engine generator and enclosure; including:
        1) 125 amp main lug only panelboard connected to a 120/208VAC utility service by the installer.

2) Two duplex GFI receptacles, one inside the enclosure, and one outside the enclosure. Both receptacles shall be weather-resistant type, GFCI, with weatherproof in-use covers.

3) Factory wired normal AC service from the panelboard to the engine coolant heater, alternator heater, and battery charger.

4) Interior Lights with Switch: Two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures.

c. External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.

11. Generator Outdoor Housing: Provide a weatherproof and rodent-proof outdoor shelter to entirely enclose each generator set, including batteries. Silencers shall be installed on or inside the enclosure. Enclosure shall have a fixed intake louver with bird screen and a grill protected radiator discharge opening. Enclosure shall have hinges and gasketed access doors and access panels to allow complete unit operation and maintenance without removal of the enclosure. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted in the manufacturer's standard color.

PART 3 - EXECUTION

3.1 INSTALLATION OF ENGINE-DRIVEN GENERATOR SETS:

A. General: Install standby engine-driven generator sets where shown, in accordance with the equipment manufacturer's written instructions and recognized industry practices, to ensure that the sets comply with the specified requirements and serve the intended purposes.

B. Standards: Comply with NEMA standards, requirements of the NEC and applicable portions of NECA's "Standard of Installation" pertaining to installation of standby engine-driven generator sets and accessories.

C. Vibration Mounts: Install units on properly sized spring type vibration mounts and ribbed neoprene vibration isolators; comply with manufacturer's indicated installation method as applicable.

D. Concrete Pad: Install generator set on a 3-1/2" reinforced concrete pad. The generator pad shall extend 6" beyond the generator set base, unless shown otherwise. Furnish the exact position of any block-outs, mounting bolts, and the dimensions and location of the generator pad in a timely manner so as to prevent delay of the concrete work. Refer to Section 26 05 01, "Basic Materials and Methods", for additional requirements.

E. Wiring: All feeders/conduits for generator and emergency power feeders shall be installed as follows:

1. Horizontal feeder/conduits shall be installed below grade, below a slab on grade, be enclosed in an approved 2 hour enclosure or utilize UL listed 2 hour rated conductors. Where a 2 hour enclosure is required, coordinate enclosure with the General Contractor.

2. Vertical feeders/conduits shall be installed in a 2 hour rated chase or room, be enclosed in an approved 2 hour enclosure or utilize UL listed 2 hour rated conductors.. Where a 2 hour enclosure is required, coordinate enclosure with the General Contractor.

3.2 GROUNDING:

A. General: Install the generator(s) as a separately derived system. Ground the generator neutral at the frame. Refer to Section 26 05 26, "Grounding and Bonding for Electrical Systems", for additional requirements.

3.3 CONTROL WIRING:

A. General: Provide generator start-up control wiring from each automatic transfer switch to the standby generator set.

B. Annunciators: Provide control wiring to remote generator annunciators in locations specified and as shown on the Drawings.

3.4 COORDINATION:

A. Natural Gas Piping: Natural gas piping shall be furnished and installed under Division 22.

3.5 INITIAL START-UP AND SYSTEM CHECKOUT:

A. A complete installation shall be initially inspected, adjusted and started and checked out for operational compliance by representatives of the manufacturer.

B. The engine lubrication oil and antifreeze shall be provided by the supplier of the electric set for operation under environmental conditions as recommended by the manufacturer.

3.6 TESTING:

A. General: Upon completion of installation of engine-driven generator set(s) and transfer switches, and after building circuitry has been energized with normal power source, test emergency power system to demonstrate standby capability and compliance with specified requirements, including automatic start-up, controls, and full load acceptance. Tests shall include operation of standby power system with voltage check while the system is loaded to ensure proper operation of the emergency generator, transfer switches, natural gas supply and other system components. Operation of the system shall simulate standby power conditions, that is, loss of main electrical power to the building. Test period shall be a minimum of 2 hours continuous trouble-free operation with at least four automatic transfer switch operations for each switch within the period of operation.

B. Test Load: Testing shall be performed at 0.8 PF with loads as specified hereinbelow. Where the specific set has been factory tested at 0.8 PF as specified hereinbelow, field-testing may be performed at 1.0 PF. The supplier of the engine-generator set shall provide a load bank of sufficient capacity to complement the available building load for testing. The field test shall include running the emergency power system under loads as specified below:

1. 30 minutes at 25% of rated load (field load bank).
2. 15 minutes at 50% of rated load (field load bank).
3. 15 minutes at 75% of rated load (field load bank).
4. 30 minutes at 100% of rated load (field load bank).

5. Miscellaneous building loads may be used to supplement load bank.

C. Test Readings: The voltage current and frequency readings shall be recorded at 15 minute intervals throughout the test. Each automatic transfer switch shall automatically operate a minimum of four times during the test. There shall be a 15 minute unloaded run at the conclusion of the test to allow engine to cool before shutdown. The Contractor shall make all necessary hook-ups to facilitate field-test and shall furnish all fuel necessary for field-testing. Refer to Section 26 01 25, "Electrical Testing", for additional testing requirements.

D. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include date and time of test, relative humidity, temperature, and weather conditions.

3.7 OPERATOR TRAINING:

A. The manufacturer's start-up representative shall provide a minimum of 2 hours of operating and maintenance training to the Owner's maintenance personnel. Training shall be provided at times convenient to the Owner. Approved Operating and Maintenance Manuals shall be available to the Owner prior to the training session.

B. Instructions and Drawings: Complete instructions, consisting of operating and maintenance manuals, parts book, dimensional drawings, separate unit wiring diagrams and schematics and interconnecting wiring diagrams shall be provided as part of the project operating and maintenance manuals.

3.8 IDENTIFICATION:

A. General: Refer to Section 26 05 53, "Identification for Electrical Systems", for requirements concerning painting, nameplates, and labeling.

END OF SECTION 26 32 13

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide automatic transfer switch work as shown, scheduled, indicated, and as specified.

1.3 STANDARDS:

A. Equipment shall comply with the following standards:

1. UL 1008.
2. NEC.
3. NFPA 110 - Standard for Emergency and Standby Power Systems.
4. NFPA - Life Safety Code.
5. ANSI/IEEE C37.90a – Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
6. NEMA Standard ICS-109.21 - Impulse Withstand Test.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Automatic Switch Company.
2. Cummins Power Generation/Onan.
3. Russelectric, Inc.
4. Zenith Controls, Inc.
5. Generac.

B. NEC and NFPA Compliance: Comply with applicable portions of the NEC (NFPA 70) including, but not limited to, emergency and standby power system.

C. Standards: The automatic transfer switches shall conform to the requirements of NEMA Standard ICS 2-447 and Underwriters' Laboratories UL-1008 and shall be UL-listed as follows:

1. For use in emergency and stand-by systems in accordance with Articles 517, 700, 701 and 702 of the National Electric Code.

2. Rated in amperes for total system transfer including control of motors, electric discharge lamps, electric heating, and tungsten filament lamp loads as referred to in Paragraph 1.7 and 1.9 of UL-1008.

D. Factory-Testing: All production units shall be subjected to the following factory tests:

1. The complete automatic transfer switch shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

2. Each switch shall be subjected to a dielectric strength test per NEMA Standard ICS 1-109.21.

3. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472 (ANSI C37.90a) and the impulse withstand voltage test in accordance with the proposed NEMA Standard ICS 1-109.

E. Performance Tests: Certified independent laboratory test data on a switch of the same design and rating shall be provided to confirm the following switching abilities:

1. Overload and endurance at 480 volts AC per Tables 25.1, 25.2, 27.1 and 27.2 of UL-1008 when enclosed according to NEMA Standard ICS 2-447 and UL 1008.

2. Temperature rise tests after the overload and endurance tests to confirm the ability of the transfer switches to carry their rated current within the allowable temperature limits of the insulation in contact with current carrying parts.

3. Withstand current tests per Paragraph 31 of UL-1008 for 200,000 amperes rms symmetrical when protected by fuses and at fault currents per UL-1008 when protected by circuit breakers, at 480 volts and X/R ratio of 6.6.

4. No welding of contacts. Transfer switch must be operable to alternate source after the withstand current tests.

5. Dielectric tests at 1960 volts, RMS, minimum after the withstand current test.

F. Warranty: The automatic transfer switches shall be warranted for a period of 5 years from the date of Substantial Completion.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Completely identified and marked catalog cuts of automatic transfer switches all associated equipment and devices, with all non-applicable items crossed out, and applicable equipment or devices clearly highlighted or identified.

2. Interconnecting wiring diagrams to indicate all external interlock control wiring terminal connections.

3. Complete bill of material for all equipment.

4. Complete warranty information as specified.

5. Additional information as required in Section 26 00 01.

1.6 STORAGE AND HANDLING:

A. Deliver automatic transfer switches in factory-fabricated water-resistant wrapping.

B. Handle transfer switches carefully to avoid damage to material component, enclosure, and finish.

C. Store transfer switches in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES:

A. General:

1. Provide automatic transfer switches with number of poles, voltage and full load current rating as shown or required. The neutral, where present shall be switched using a four pole transfer switch with a full size neutral pole. Transfer switches shall be UL-listed per applicable UL standards as a recognized component for emergency systems and rated for all classes of loads. Sizes rated below 400 amperes shall also be rated for 100% tungsten lamp loads.

2. Automatic transfer switches shall be product of a quality manufacturer regularly engaged in the design, development and manufacture of solid-state electromagnetic switching devices with adequate testing facilities and a recognized quality control program to ensure product output reliability, performance and safety.

3. Automatic transfer switches (ATS) shall form a complete grounded, continuous-duty, integral assembly which is metal enclosed, dead front, and suitable for the voltage, amperage, load starting characteristics and environment where the switches shall be installed.

4. The manufacturer of the ATS units shall furnish switches complete and ready to operate with only the wiring connections to field devices left upon installation of the ATS.

5. Each ATS shall have been factory-tested for correct and proper operation as outlined in these Specifications.

B. Construction:

1. The transfer switch shall be electrically operated by a single non-fused solenoid or motor operator, momentarily energized from the source to which the load is to be transferred. The complete time of transfer, measured from the instant the operator is energized until the main contacts close on the alternate source, shall not exceed 1/3 of a second.

2. The transfer switch shall be mechanically locked in each direction without depending upon gravity, gear mechanisms, latches, or hooks. Release of the locking mechanism shall be possible only by normal operation of the electrical operator.

3. Main contact travel shall be smooth and continuous, with no momentary pause or delay, throughout the transfer operation. There shall be no possibility of a neutral position or for both sides to be closed simultaneously. An overload or short circuit shall not cause the switch to go to a neutral position.

4. Main contacts shall be silver alloy, wiping action type, protected by arc barriers with separate arcing contacts on all sizes. Blow-on construction, with rigid movable contacts and deflection by the stationary contacts, shall be furnished on all switches rated 400 amperes and higher. Electrical spacing shall not be less than those specified in Table 3 of UL Standard 1008.
5. Inspection and replacement of stationary and movable main contacts shall be possible from the front of the switch without major disassembly of associated parts, without disconnection of the power conductors or main operator linkages, and without removal of the switch from the enclosure.
6. Main contacts consisting of assemblies or subassemblies, not originally manufactured for transfer switch service, shall be fully identified (name of the original manufacturer, catalog number and original electrical ratings). Any modifications made to the original products shall be described at the time of submittal.
7. Each automatic transfer switch shall consist of a power transfer module and a control module, interconnected to provide complete automatic operation.
8. Switches shall be rated for continuous duty, shall be inherently double throw and shall be mechanically interlocked to ensure only one of two possible positions: (a) normal or (b) emergency.
9. Automatic transfer switches shall be suitable for use with "emergency" sources such as an engine or turbine driven generator source or another utility source.
10. The control module shall be supplied with a protective cover and be mounted separately from the transfer switch for ease of maintenance. The interconnecting wiring harness shall include a disconnect plug to disconnect all wires including both sources of control power for routine maintenance.
11. Sensing and control logic shall be solid-state and mounted on plug-in printed circuit boards. Printed circuit boards shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial control grade plug-in type with dust covers.
12. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to stop the contacts at any point throughout the entire travel to properly inspect and service the contacts when required.
13. Automatic transfer switches utilizing components of molded case circuit breakers, contactors, or parts thereof which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.
14. The automatic transfer switches shall be mounted in NEMA 1 non-ventilated wall-mounted or floor-mounted enclosures. Switches and accessory devices shall have number of poles rated as shown on the plans.
15. All metal surfaces, both inside and outside the cabinet, shall be primed and painted with ANSI 61, light gray, enamel-based paint.
16. Doors shall be hinged and lockable.
17. All components of the operating mechanisms and mechanical interlocks shall be insulated or grounded.

C. Operation:

1. The automatic transfer switch control panel shall utilize solid-state sensing on "normal" and "emergency" for automatic, positive operation. The following shall be provided:
   a. Three phase automatic transfer switches - all phases of the "normal" source and of the "emergency" source shall be monitored line-to-line with close differential voltage sensing.
   b. The "pickup voltage" shall be adjustable from 85% to 100% of nominal.
   c. The "dropout voltage" shall be adjustable from 75% to 98% of the pickup value.
   d. The starting of the emergency source stand-by power system will be initiated upon "normal" source failure, or upon reduction of the "normal" source voltage to 80% of normal voltage.
   e. Independent frequency sensing of the "emergency" source shall be provided.
   f. The "pickup frequency" shall be adjustable from 90% to 100% of nominal.
   g. The "transfer-to-emergency" will be initiated when the "emergency" source voltage is 90% or more of nominal voltage, and the frequency of the "emergency" source is 95% or more of nominal.
   h. The "retransfer-to-normal" shall occur when "normal" source voltage restores to 90% of nominal voltage. Retransfer time delay to "normal" source shall be adjustable from zero to 30 minutes. Set time delay at 30 minutes. The time delay shall be automatically bypassed if the "standby" source fails. The ATS shall automatically retransfer to the "normal" source if the "standby" source fails and the normal source is available.
   i. An in-phase monitor relay shall be provided and shall be wired and factory set such that hot source to hot source transfer in either direction is inhibited until the phase angle of both sources is within a 15 degree band. The in-phase monitor shall check for synchronization rather than simply being a time delay transfer.
   j. Additional auxiliary contacts and interlocks as required for control functions listed in Paragraph 3.2.
2. Time Delay:
   a. A time delay to override momentary "normal" source outages to delay all transfer switch and engine starting signals. The time delay shall be field-adjustable from 0.5 to 6 seconds and factory-set for 4 seconds.
   b. A time delay on "transfer-to-emergency" for the automatic transfer switch(es) shall be field adjustable from zero (0) to 60 seconds and shall be initially as follows:

      ATS 0 seconds
   c. Time delays on "transfer-to-emergency" and "retransfer-to-normal" for the Elevator automatic transfer switches shall be field adjustable from zero to 60 seconds and shall be initially set at 30 seconds. Refer to additional requirements for Elevator Automatic Transfer Switches hereinafter specified.
   d. A time delay on "retransfer-to-normal" source shall be automatically bypassed if the "emergency" source fails and "normal" source is available. The time delay shall be field-adjustable from zero to 30 minutes and factory-set at 30 minutes.

e. A time delay for "shut-down" of the emergency generator set to provide unloaded running of the engine for cool-down. The time delay shall be field-adjustable from zero to 10 minutes and field-adjusted for the time setting as recommended by the stand-by generator set manufacturer.

f. All time delays shall have an indicator to show the time delay setting including the units of measure used in the setting.

3. Engine Control Contacts: A contact that closes when "normal" source fails for initiating engine starting, rated 10 amps, 32 volts dc. Contacts to be gold plated for low voltage service.

4. Auxiliary Contacts:

a. Three auxiliary contacts that close when the automatic transfer switch is connected to "normal" source, rated 10 amps, 480 volts, 60 Hz ac. These contacts shall be in addition to those required for ATS indicators, monitoring and control interlock functions.

b. Three auxiliary contacts that close when the automatic transfer switch is connected to "emergency" source, rated 10 amps, 480 volts, 60 Hz ac. These contacts shall be in addition to those required for ATS indicators, monitoring and control interlock functions.

5. Manual Controls:

a. A test switch to momentarily simulate normal source failure. Refer to elevator automatic transfer switches for additional requirements.

6. Indicator Lights:

a. Two green indicator lights shall be provided, one to indicate normal source available and one to indicate load connected to normal source.

b. Two red indicator lights shall be provided, one to indicate emergency source available and one to indicate load connected to emergency source.

7. Generator Exercise Timer:

a. A clock exerciser shall be furnished (in ATS-E) to automatically start the electric set at regular intervals and allow it to run for a preset time period, minimum of 30 minutes per week. A selector switch shall permit selection of "without load" or "with load" operation. "Without load" the electric set runs unloaded and "with load" the automatic transfer switch transfers the load to the electric set, after appropriate time delays, the same as it would for a normal source interruption.

b. Day and time shall be set as directed by the Owner. Time switch shall have battery backup or a spring wound reserve timer.

8. Serial Communications Ports: Each transfer switch shall have an RS-422 serial communications port and interface board to allow remote annunciation and control of the transfer switch from the transfer switch remote annunciator or a future network supervisor. Serial Communications System will be equal to the Asco serial communications network.

9. Remote Transfer Switch Annunciator(s):

a. Provide a microprocessor based remote transfer switch annunciator(s) shall be provided to provide remote status reporting and testing of each transfer switch. The annunciator shall be equal to the Asco No. 2140A400 annunciator and shall communicate with the transfer switches through a RS-422 serial communications network.

b. The annunciator(s) shall operate on 12 or 24 volts dc and shall be furnished with a 120 volt input power supply and backup battery power source located at the annunciator location.

D. Ratings:

1. Withstand Rating: RMS symmetrical fault current per Paragraph 9.9 of UL-1008 (dated July 6, 2012) for transfer switches protected by current-limiting fuses and circuit breakers.

2. Overload Rating: 50 operations, six times rated current, 0.40 to 0.50 power factor.

3. Endurance Rating: Ratings 1 to 1200 amperes; 6000 operations (0.40 to 0.50 power factor, 200% rated current).

4. Mechanical Durability: 100 operations, no-load, at a rate not less than one operation per second.

5. Interrupting Rating: 50 operations, any magnitude of current between 1% and 100% of rated current, 0.40 to 0.50 power factor.

6. Closing Rating: Inrush to 20 times rated current.

7. Thermal Rating: 20 times rated current, one second duration.

8. Temperature Rise: The manufacturer shall have performed tests on similar switches and the above ratings shall be based on using the same contacts for a series of tests without service or replacement of contacts. After testing, the maximum stabilized temperature rise of the main contacts carrying rated load in a non-ventilated enclosure shall not exceed NEMA standards (65°C rise).

E. Spare Parts and Tools:

1. Provide five spare indicating lamps for each ATS.

2. Provide one set of all tools required for normal maintenance at ATS.

PART 3 - EXECUTION

3.1 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES:

A. General: Automatic transfer switches shall be installed, including all connections, where and as indicated on Drawings and wiring diagrams as specified herein, and in accordance with approved Shop Drawings and manufacturer’s instructions.

B. Standards: Comply with the requirements of NEMA and NEC standards and applicable portions of NECA's, "Standard for Installation", for transfer switches.

C. Tightness: Torque bus connections and tighten mechanical fasteners.

D. Concrete Pad: Install floor-mounted transfer switches on a reinforced concrete pad. The ATS pad shall extend 3" beyond the switch enclosure, unless noted otherwise. Switch shall

be bolted to the housekeeping pad using 3/8" minimum galvanized bolts and anchors on 30" maximum centers. Furnish the exact location of any blockouts, dimensions, and locations of the housekeeping pads in a timely manner so as to prevent delay of the concrete work. Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for additional requirements.

E. Adjustment: Adjust operating mechanisms for free mechanical movement.

F. Finish: Touch-up scratched or marred surfaces to match original finish.

3.2 CONTROL WIRING:

A. General: Provide control wiring from each automatic transfer switch to the generator for generator starting.

B. Ensure that the generator control wiring complies with NEC 700.10(D)(3). “The integrity of the generator control wiring shall be continuously monitored. Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and the start generator(s).

C. Elevator Emergency Operation: Provide control wiring as required from automatic transfer switch emergency position indicating and presignal contacts to the emergency operation terminals on each elevator controller served by that transfer switch, for initiating the emergency operating sequence. Control wiring shall be installed in a suitable raceway.

D. Annunciator Wiring: Provide wiring between transfer switches and to transfer switch annunciator. Communications wiring shall be installed in a suitable raceway.

E. Auxiliary Contacts: One additional N.O. auxiliary contact which closes when ATS is connected to normal power and one additional N.O. auxiliary contact which closes when ATS is connected to standby power. These contacts are for future use and are in addition to any contacts required for control, interlock, or monitoring functions.

3.3 COORDINATION:

A. Control Wiring: Coordinate control wiring connections and provisions with Division 14 for elevators. This coordination shall be the responsibility of this Division.

B. Instructions and Drawings: Complete instructions, consisting of operating and maintenance manuals, parts book, dimensional drawings, separate unit wiring diagrams and schematics and interconnecting wiring diagrams shall be provided to the Engineer within 30 days of completion of the project.

3.4 TESTING:

A. Pre-energization Checks: Prior to energization, check automatic transfer switches for continuity of circuits and for short circuits.

B. General:

1. The complete installation shall be initially operated and checked out for operational compliance by representatives of the manufacturer of the automatic transfer switches.

2. Upon completion of initial start-up and system checkout, the supplier of the automatic transfer switches or his authorized representative shall perform a field test, witnessed by the engineer, to demonstrate full compliance with all requirements of the specification, but not be limited to demonstration of proper operation of all control interlocks and a

minimum of four automatic operations of each transfer switch. This testing shall be performed in conjunction with standby generator system testing.

C. Reporting: Upon completion of the field test, four copies of the final report shall be documented, certified, and sent to the Engineer for distribution to the Owner or authorized Owner's representative, indicating that all automatic transfer switches in conjunction with the standby electric power system have been tested and are 100% operational.

D. Thermographic Testing: Refer to Section 26 01 25, "Electrical Testing", for thermographic testing.

3.5 OPERATOR TRAINING:

A. The manufacturer's startup representative shall provide a minimum of 8 hours of operating and maintenance training to the Owner's maintenance personnel. Training shall be provided at times convenient to the Owner. Approved Operating and Maintenance Manuals shall be available to the Owner prior to the training session.

3.6 IDENTIFICATION:

A. Refer to Section 26 05 53, “Identification of Electrical Systems” for applicable painting, nameplates, and testing.

END OF SECTION 26 36 23

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SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 SECTION INCLUDES:

A. Work Included: Provide lightning protection system work as shown, scheduled, indicated, and as specified.

1.3 STANDARDS:

A. Products and installation shall comply with applicable sections of the latest edition of the following standards:

1. LPI-175 Standard for the Design-Installation – Inspection of Lighting Protection Systems.
2. UL 96 Standard for Lighting Protection Components.
3. UL 96A Standard for Installation Requirements for Lighting Protection Systems.

B. A complete Lightning Protection System shall be provided for the entire building.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Only firms regularly engaged in the manufacture of lightning protection system components whose products have been in satisfactory use in similar service for not less than 5 years shall be used.

B. Installer: System installed shall be a licensed electrical contractor, LPI certified Master Installer or a n installer with a minimum of 5 years experience as a UL Master Label Installer.

C. LPI Compliance: The entire installation shall be in accordance with the LPI "Lightning Protection Installation Code", LPI-175 (latest edition), for Class I installations.

D. Underwriters' Laboratories, Inc. (UL) Labels: All conductors shall bear UL Label at 10' intervals along the length of the conductor. All air terminals shall bear UL Label. The completed installation shall be awarded the Master Label Certificate per UL 96A (latest edition).

1.5 SHOP DRAWING SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Manufacturer's data and cutsheets on all system components including, but not limited to air terminals, braces, and mounting base, main conductors, branch (secondary) conductors, ground electrode (rod, wing plate, or ground plate), bimetal splicers, clamps, fittings, and connectors, and method of roof flashing.

2. Dimensioned drawings in plan view (and riser) showing accurately scaled air terminal layouts, main and branch conductor routing, down conductor location, ground electrode and inspection pit locations, counterpoise routing and all bodies of conductance and inductance connected to the system.
3. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Store lightning protection system materials in a clean, dry space.

B. Handle carefully to avoid damage or bending of air terminals and components.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: All components of the system shall individually meet the factory inspection requirements of UL 96A for lightning protection materials. All materials shall comply in weight, size, and composition with the requirements of the Underwriters' Laboratories, Inc. and the National Fire Protection Association Code relating to this type of structure. Materials shall be designed for their intended use, and shall meet the factory inspection requirements of Underwriters' Laboratories, Inc. Provide products as specified in the following paragraphs:

1. Air Terminals: Chrome-tipped, solid copper or aluminum, 98% conductivity, sized per Table 3-1.1a, Class I of NFPA 780 (latest edition).
2. Air Terminal Base Plate: Compatible copper or aluminum suitable for intended mounting.
3. Main and Secondary Conductors, Class I: Copper or aluminum conductors, sized per Table 3-1.1a, Class I of NFPA 780 (latest edition).
4. Ground Electrode: Copper rod, wing plate, or ground plate as required by soil conditions and as required for optimum performance of entire system. Aluminum will not be acceptable.
5. Miscellaneous Hardware: Copper or aluminum, electrically compatible with other major components of the system.
6. Fasteners: A UL-approved type of noncorrosive metal having ample strength to support the conductor.
7. Connectors: Provide connectors as follows:
    a. Cable Connectors: UL-approved copper, copper-bronze, or cast bronze for use with copper conductors. Provide screw-pressure type using stainless steel bolts and nuts. A UL-approved fusion weld similar to "Cadweld" may be used for underground copper connections.
    b. Connections to Building Steel or Reinforcing Steel: A UL-approved fusion weld similar to "Cadweld".
    c. Dissimilar Metals: A UL-approved bimetallic connector.

d. Connections to Ground Rods: A UL-approved clamp, or a UL-approved exothermic weld similar to "Cadweld".

PART 3 - EXECUTION

3.1 CERTIFICATION:

A. General: The entire installed lightning protection system shall be an LPI-certified lightning protection system complying with requirements of UL 96A (latest edition) for a Master Label C, which shall be furnished. The installation shall be in accordance with recognized industry practices to ensure that products serve the intended function. All parts of the Lightning Protection System shall be bonded together. The Lightning Protection System shall be installed by a bonded Lightning Protection System Contractor who specializes in lightning protection system engineering and installation.

B. Equipment shall be located as inconspicuously as possible. Wiring run inside building shall be installed in conduit. Provide installation diagrams for approval before proceeding.

3.2 INSTALLATION:

A. Aluminum Materials:

1. Aluminum conductors will not be permitted for installation underground or in corrosive or salt laden atmospheres. If aluminum systems are employed, suitable bimetallic connectors shall be used ahead of copper ground electrode and counterpoise.

2. Aluminum materials may be employed at any location where aluminum materials are used on the structure, are contiguous to the lightning protection system elements, and are approved by the Engineer. All aluminum elements shall be sized for equal ampacity and conductivity as required for copper.

B. Exothermic Welds: Exothermic welds will not be permitted on loose weave conductors, but may be used on conductors which are stranded tightly, for sizes 197 MCM and larger.

C. Down Conductors: Down conductors shall be concealed at all points within the structure.

D. Visual Access: All points of connection shall have visual access. Provide visual access via inspection pits and similar means.

E. Cable Runs: Provide a perimeter cable run around the perimeter of the main roof and all penthouses. Provide other cable runs to meet specified requirements. Provide downleads as required to bond cable runs to ground electrodes. Where building structure is steel, the building steel may be used for downleads where permitted.

1. Roof: Exposed and fastened 3' on center maximum. Cable bend shall be minimum 8" radius with maximum 90 degree bends.

2. Underground: Copper cable direct buried.

3. Down Conductors: Concealed and installed in a minimum one inch (1") PVC conduit.

F. Air Terminals: Provide 18" projection air terminals at a maximum spacing of 20' around perimeter cable runs, and 24" projection air terminals at a maximum spacing of 25' apart through the center of flat roofs.

G. Metal Bodies of Conductance: Bond all metal bodies of conductance which are located on the roof to the lightning protection system. This includes, but is not limited to exhaust fans, vents, handrails and ladders, metal screens and panels, air conditioning units, pumps, hatches, flag poles, antennas, and any metal body which exceeds the height of air terminals.

H. Metal Bodies of Inductance: Bond all metal bodies of inductance located within 6'of a cable run or bonded object to the Lightning Projection System. This includes, but is not limited to: flashings; metal coping caps; gravel guards; fascias; roof drains; downspouts; interior ducts, equipment and piping; or in general, any isolated body at or below the roof in the 6'zone mentioned above.

I. Roof Penetrations: Use properly flashed fittings for non-leaking roof penetrations at downleads and other areas where roof penetrations are required.

J. Ground Electrodes: Ground rods shall be driven so that the bottom of the rod is at least 10'below grade and not less than 2'from the building wall.

3.3 TESTING:

A. Ground Resistance Test: Perform a ground resistance test for comparison to future inspection and testing data by the Owner. Overall system resistance shall not exceed 25 ohms total. Test shall be performed using a Biddle Megger Earth Tester or equivalent test instrument.

B. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit two copies of certified test results for Owner's record and submit four copies of certified test results to Architect for review. Test reports shall include time and date of tests, relative humidity, temperature and weather conditions.

END OF SECTION 26 41 13

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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.02 DESCRIPTION OF WORK:

A. Work Included: The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.

B. Types: The types of lighting fixtures required for the project may include, but are not limited to:

1. Fluorescent fixtures.
2. LED fixtures.
3. Exit signs.
4. Light fixture emergency battery pack units.

C. Applications: The applications of lighting fixtures required for the project include, but are not limited to:

1. General lighting.
2. Specialty lighting.
3. Emergency, egress and exit lighting.

D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

E. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.

F. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

1.03 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. NFPA 101 Life Safety Code.
2. NEMA WD1 General-Purpose Wiring Devices.
3. ANSI C82.1 Line Frequency Fluorescent Lamp Ballasts.

1.04 QUALITY ASSURANCE:

A. Any alternate lighting package shall be submitted and approved prior to bid. After bidding no alternate packages will be accepted. Alternate packages shall include photometric calculations for the project including egress lighting calculations to ensure design light levels are met.

B. Manufacturers: Provide products produced by manufacturers as shown or scheduled for each type of lighting fixture. Identification in the fixture schedule by means of manufacturers' names and catalog numbers is to facilitate establishment of basic features, construction and performance standards. Any substitutions must, in the opinion of the Engineer and Lighting Consultant, meet or exceed these standards. Provide products complying with these specifications and produced by one of the following for ballasts, drivers, lamps, LED light sources and battery back-up units:

1. Light Fixtures
   a. Manufacturers as listed or scheduled on the Drawings.
2. Ballast/Driver Manufacturers:
   a. Philips (Advance Transformer Company).
   b. Universal/Magnetek.
   c. Osram Sylvania.
   d. Lutron Electronics.
3. Lamps/LED Light Sources:
   a. Cree.
   b. General Electric Company.
   c. Osram Sylvania.
   d. Phillips Lighting Corporation.
4. Emergency Battery Back-up Units:
   a. Philips Bodine Emergency Lighting.
   b. Chloride.
   c. Lithonia.

C. CBM Label: Provide fluorescent ballasts which comply with Certified Ballast Manufacturers' Association (CBM) standards and carry the CBM mark on the label.

D. Conformance: Fixtures shall be manufactured in strict accordance with the Drawings and Specifications.

E. Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable federal, state, and local codes and regulations.

F. UL-listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. "Standards for Safety," and others as they may be applicable. A UL-listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

G. Warranty: All ballasts shall be provided with a two (2) year parts and labor warranty from the date of project acceptance. All LED light sources and drivers shall be provided with a 5 year warranty.

1.05 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. Submit manufacturer's data on interior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by fixture "type" in alphabetical order, with the

proposed fixture and accessories clearly labeled. Ballast, driver and lamp/LED light source product data shall accompany fixture submittals.

2. Submit LM-80 lumen depreciation test results and L70 rated life test results for each type of LED source package, array or module being submitted for the project.
3. Submit dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency and visual comfort probability.
4. Submit details of fixture mounting including frames, trims, canopies, support requirements, and other data pertinent to fixture installation.
5. Submit complete photometric data for each fixture, including optical performance and efficiency rendered by independent testing laboratory developed according to methods of U.S.A. Illuminating Engineering Society as follows:
   a. For down and semi-down lights used for general illumination: (1) Coefficients of utilization; (2) Visual Comfort Probability data for 100 footcandles, in a 20' by 20' room with 10' ceiling and luminaires lengthwise with reflectances of 80% (ceiling), 50% (walls), and 20% (floor); (3) Candlepower data, presented graphically and numerically, in 5 degree increments (0 degrees, 5 degrees, 10 degrees, etc.). If light output is only bilaterally symmetric, data also developed for up and down quadrants normal, parallel, and at 22-1/2 degrees, 45 degrees, and 67-1/2 degrees to lamps; and (4) Zonal lumens stated numerically in 10 degree increments and at angles to lamps as described above.
   b. Supply photometric data as described above for any fixture offered in substitution for a specified fixture.
6. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver interior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.

B. Handle interior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store interior lighting fixtures in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS:

A. General: Provide lighting fixtures, of the size, type and rating indicated on the Lighting Fixture Schedule, complete with, but not necessarily limited to, lamps, lampholders, LED light sources, reflectors, diffusers, louvers, wire guards, tube guards, ballasts, fuses, starters, and wiring. Fixtures shall be furnished with all required accessories and trim, including hold-down clips, as required for a complete installation in the ceiling-type shown on the Architectural Drawings.

1. Lighting equipment shall be complete, wired, and including supporting means, such as plaster frames, supports, hangers, canopies, sockets, holders; current or voltage modifiers, such as ballasts, starters; light control materials; specifically diffusers, louvers, lenses, reflectors and refractors; and lamps.

2. Lighting fixtures shall be designed for highest relative efficiency and service. Maintenance to be simple and relamping possible without use of special tools.
3. Lighting fixtures shall be constructed and installed in accordance with local building codes and shall bear label of approved testing agent. Materials shall be new and of best grade of approved manufacturing standards. Workmanship shall be of highest order.
4. Recessed fixtures shall be provided with frames appropriate construction encountered.
5. Ferrous fixture components shall receive treating to assure corrosion resistance and paint adherence. Aluminum parts, unless made of alloys having inherent corrosion resistance, shall be anodized or coated with oxidation-preventing treatment. Finish shall be baked enamel where color is indicated.
6. Plastic shall be acrylic.

B. General Fixture Construction:

1. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.
2. Fabricate fixture enclosures with a minimum of No. 22 gauge cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength, and acceptable to the Engineer/Lighting Consultant.
3. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion during shipping, installation, and while in normal use.
4. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.
5. All custom light fixtures shall be thoroughly tested in Manufacturer's shop prior to shipment to ensure mechanical and electrical integrity.
6. All fixtures shall be completely wired at the factory.
7. If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
8. Fixture to be sealed against light leaks between ceiling trims of recessed and semi-recessed lighting equipment and the ceilings. If fixture is used in partially transparent ceiling, fixtures to be sealed against light leaks above the ceiling line.
9. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be provided as required.
10. Fixtures for use in areas designated as wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Damp location fixtures to be of corrosion resistant parts and hardware.

11. In the application and mounting condition specified, fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc.
12. Each lighting fixture which has a beam angle adjustment shall have reliable angle locking device capable of long and continuous use.
13. Each lighting fixture which has a lamp with an oval shape beam pattern shall contain a lamp orientation locking device which will insure that beam orientation is not disturbed during lamp replacement and fixture cleaning.
14. Each light fixture which has a spread lens shall contain lens orientation locking device which will insure that lens orientation is not disturbed during lamp replacement and fixture cleaning.
15. All lamp sockets in lighting fixtures shall be suitable for the specified lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for the specified lamp . If different socket positions are specified for various types of the same fixture, sockets shall be preset for each type, and cartons marked accordingly.

C. Reflectors and Trims:

1. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.
2. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of 10 years, and, in the event of premature discoloration, shall be replaced at the expense of the manufacturer for both materials and the cost of labor.
3. Aluminum reflectors shall be finished specular, semispecular, or diffuse as specified and shall meet or exceed Alzak specifications. Minimum requirements for reflector finishes for interior service shall be as follows:

DESCRIPTION OF SERVICE	MINIMUM PERCENT OF COATING MG. PER SQUARE INCH	MINIMUM WEIGHT REFLECTANCE SPECULAR	DIFFUSE
Normal interior commercial service	5.0	83	75
General interior industrial work reflector protected by glass covering	7.5	82	73

D. Lenses:

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohn & Haas, Dupont or as acceptable to the Engineer/Lighting Consultant. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional

instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2. Glass used for lenses, refractors, and diffusers in incandescent and HID lighting fixtures shall be tempered for impact and heat resistance; the glass shall be crystal clear with a transmittance of not less than 88%. For fixtures with a radiant energy of 4.16 watts per square inch or greater, directly exposed to the elements and aimed above the horizontal, use Vycor glass.
3. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.
4. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.
5. All lenses shall be clean and free of dust at the time of substantial completion.

E. Lamp Holders:

1. Fluorescent:
   a. Body: White urea plastic.
   b. Contacts: Phosphor bronze.
2. Lamp holders in lighting fixtures shall be suitable for indicated lamps and shall be positioned to place lamps in optically correct locations in relation to fixture components. If adjustable socket positions are provided, socket should be present in factory for lamp specified. If different socket positions are specified for same fixture, sockets shall be preset for each type, and cartons marked accordingly.
3. Furnish lamp holders which are UL-listed and designed for proper lamp operation and life.

F. Finishes:

1. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350°F minimum, catalytically or photochemically polymerized after application.
2. White Finishes: Minimum of 85% reflectance.
3. Frames: Ceiling opening frames shall either be manufactured of nonferrous metal, or be suitably rustproofed after fabrication.
4. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.
5. Undercoat: Except for stainless steel, provide ferrous metal surfaces with a five stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.
6. Unpainted Surfaces: Unpainted nonreflecting surfaces shall be satin-finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
7. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect.

8. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reluctance of not less than 85%.

G. Fixture Fabrication:

1. General: Design components to allow for expansion and contraction for a minimum ambient temperature range of 150°F (37.8°C) without causing buckling, excessive opening of joints or over-stressing of welds and fasteners.
2. Sheet Metal Work: Form metalwork to required shapes and sizes with true curves, lines, and angles. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of required metal. Form intersections and joints true with adequate strength and structural rigidity to prevent distortion after assembly. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners wherever possible.
3. [Castings: All castings shall be exact replicas of approved patterns and shall be free of sand pits, blemishes, scales and rust, and shall be smoothly finished. Tolerance shall be provided for any shrinkage of metal castings in order that finished castings will accurately fit in their designated locations.
4. Welding: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welded flux and dress on all exposed and contact surfaces.
5. Assembly: Accurately fit all parts of fixture. All joints in metal, not checked, shall be brazed and not soldered. Joints shall be invisible. Where screws are necessary for adjustment of applied ornament, they shall be concealed, as far as possible, and finished to match other metalwork. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration. Assembled fixtures shall be well braced, and of adequate strength to resist sagging or deforming.

H. Glass:

1. Glassware shall be mechanically strong, properly annealed, and free from internal strain that might cause breakage. Where possible glassware shall be tempered for impact and heat resistance. Unless otherwise noted, all enclosing globes shall match glass of existing fixtures, or if none exists, glassware shall match approved prototype in size, contour, finish and general appearance. Supplied globes shall faithfully reproduce existing globes or approved prototypes in every way, having qualities equal to or better than the approved prototype without sacrifice of any other characteristics such as transparency or translucency and reflection/refraction properties. Glassware supplied shall be of consistently high quality and free from such imperfections as streaks, corns, stones, blisters, checks or other flaws that affect glassware strength or appearance.
2. Dimensional Tolerances of Glass: All other dimensions of supplied globes shall not vary more than 1% more or less than the respective dimension on the approved prototype. Tolerances for glass thickness shall be set by the Architect and adhered to by the contractor. Each unit of glassware supplied shall be identical to others of that type and faithful to the approved prototype.

3. All glass ornament in relief and globes shall be blown up fully in molds so as to faithfully replicate approved samples.
4. Where shown, etch, chase or carve ornament on globes as detailed.
5. Glass Overage: Furnish 10% additional in number of each size and kind of globe (or a minimum of two, whichever is greater).

I. Wiring:

1. Generally use SF-2 insulated wire for rewiring existing or new wire at replicated light fixture. SF-1 may be substituted in those locations where space will not permit the installation of SF-2 and where the load is 6 amps or less. Provide 600 volt insulation.
2. Factory-wire all fixtures. Provide leads no shorter than 1'-0" or as required to suit the project application.

J. Connections:

1. Fasteners: Furnish fasteners of basic metal and alloy, matching finished color and texture as metal being fastened, unless otherwise indicated. For steel and aluminum fixtures, all screws, bolts, nuts, and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be bronze.
2. Welding Materials: Type and alloy of filler metal and electrolodes as recommended by producer of metal to be welded, and as required for color match, strength and compatibility in the fabricated units.

K. Fixture Types:

1. Fluorescent Fixtures: Provide fluorescent fixtures of the type scheduled on the Lighting Fixture Schedule, complete with ballasts and lamps of the type, color, wattage and size scheduled.
    a. Provide fluorescent fixtures with heavy white lampholders with definite locking-in feature and contacts for proper lamp operation and life. Sockets with open-circuit voltage over 300 volts to be safety type and designed to open the supply circuit on lamp removal.
    b. Fixture body parts, comprising fixture housing, reflectors, wire channels, end plates, ballast housings, and similar body parts, shall be made of extruded aluminum, galvanized stampings, or bonderized steel, as indicated. Housing end plates, socket bridges, reflectors, wiring channels and ballast covers shall be die formed of not less than No. 22 gauge cold rolled steel unless specified otherwise. Mount lamps on rapid-start circuits within one inch (1") of grounded metal, one inch (1") wide minimum and as long as the lamp. Wireways shall have adequate wiring space, accessible after fixture installation. Construct fixtures so that ballast may be serviced or replaced without removal of fixture housing from adjacent construction. Housing shall be adequately ventilated where required. Hardware shall have rustproof finish. Fixture bodies shall be painted after fabrication.
    c. Temperatures around ballast and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.
    d. Lighting fixtures shall have continuous light-seal gaskets seated in such manner as to prevent any light leaking through any portion or around any edge of the trim frame. Other sealing methods shall be individually reviewed.
    e. Diffusers shall be framed in hinged continuous assembly, except where frameless units are indicated. Frameless units shall be removable without tools and opened

or closed by hand pressure. Diffuser frame latches shall be spring-loaded or cam-operated.

f. Fluorescent fixture lenses, where required, shall be 100% extruded virgin acrylic, prismatic-type, nominal 0.125" thick, unless specified otherwise. Provide a minimum of eight hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
g. Fluorescent fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples, and other accessories recommended by the manufacturer for continuous row installation.
h. Fluorescent troffers shall be shipped prelamped, unless noted otherwise.
i. Parabolic louver fluorescent troffers shall be shipped with a plastic bag or film to protect the louvers from site conditions. Louver protection shall not be removed until the space where the fixture is installed is complete.
j. Supply air-type fluorescent fixtures shall be provided with adjustable air pattern control blades.
k. Lay-in fixtures shall be provided **with hold-down clips** per the NEC, minimum two clips per fixture.

1. LED Fixtures: Provide LED fixtures as scheduled on the Lighting Fixture Schedule, complete with LED light sources and drivers of the type, color, wattage and size scheduled.
   a. Provide recessed LED fixtures with trim rings compatible with the ceiling material where fixture is to be installed. LED fixtures shall be prewired equipped with integral thermal protection. LED lighting fixtures shall be appropriately listed and labeled by Underwriters' Laboratories, Inc. for their final installation, i.e., damp or wet locations, etc.
   b. LED Light Source Packages: LED light source packages, arrays and modules used in luminaires shall be tested in accordance with LM-80 lumen depreciation tests and shall have a L70 rated minimum life of 50,000 hours.
   c. For instances where LED sources are mounted directly to architecture, such as installing a strip LED using an adhesive tape, the LED manufacture shall provide a recommended heat sink volume adequate to achieve rated L70 life.
   d. Recessed fixtures shall be designed and installed to eliminate light leakage.
   e. For recessed LED fixtures where junction box is required, shall be accessible when fixture is removed. Connect to conduit system with flexible conduit containing #14 (minimum) fixture wire.
   f. Aluminum reflectors shall be Alzak (finish as selected) or as authorized and not less than 0.057" thick, unless specified otherwise.
   g. Temperatures around driver and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.
   h. All fixtures specified for recessing in ceilings shall be supplied with prewired junction boxes.
   i. LED fixtures shall have a minimum 5 year warranty covering failure of all electrical components.
2. Lighting Track: Provide a complete track lighting installation as scheduled on the Lighting Fixture Schedule, complete with fixture heads as shown or scheduled and lamps of the type, color, wattage and size scheduled.
   a. Lighting track shall be single circuit light track assembly unless specified otherwise. It shall consist of an outer housing with two electrical conductors, and

with suitable insulation between the conductors and the housing. The conductors to be tin-plated copper and the insulation shall be of high temperature vinyl. The housing shall have a moment of inertia of not less than 0.160" and shall be made of a noncorrosive material such as an aluminum extrusion of Alloy 6063 T5.

b. Grounding may be provided by the housing or by other means, and in the process of installing a fixture on the track, the grounding connection shall be automatically completed before electrical conductor contact occurs. Maximum outside dimensions of the housing shall be 1-5/8" high x 1-7/8" wide with a continuous open slot on the ceiling line not wider than 3/4".
c. The track assembly shall be rated at not less than 50 amperes at 300 volts. The insulation shall be suitable and approved for temperatures resulting from the use of several track fixtures in close array with Q250 PAR 38 lamps. A special electrical feed box shall be furnished for attachment to any location along the track, with spring mounted coverplate fitting the box neatly and mounting flush with the conductors.
d. The track shall be spliced in such a way that it is not obviously visible where the electrical and mechanical connection occurs.
e. Specially designed splice bars shall align and connect two runs of track.
f. Two push-in continuity jumpers shall be supplied to maintain electrical contact at a splice location. Track runs to be provided with 8" long #10 teflon leads.
g. The track shall incorporate means for secure mechanical attachment and simultaneous electrical feed of lighting fixtures equipped with the necessary attachment plug devices.
h. Recessed track as installed shall be absolutely flush with finished ceiling plane and absent of any gaps between ceiling material and aluminum housing. Contractor shall be responsible for making sure that recessed track integrates properly into ceiling construction and according to manufacturer's recommendations. This includes having appropriate ceiling assembly and finish material thickness.

3. Exit Signs: Provide LED exit signs as scheduled on the Lighting Fixture Schedule. Exit lighting fixtures shall meet the requirements of all applicable federal, state, and local codes.
   a. [Exit signs shall have provisions for flashing [and providing an audible tone] upon loss of power or flashing upon a signal from the building fire alarm system, where specified, scheduled, or noted on the Drawings.]
   b. Exit sign battery packs shall meet all specified requirements for Emergency Battery Backup Units as specified in Paragraph 2.1/N.

L. Ballasts/Drivers:

1. Energy Saving Electronic Ballasts - Indoor PL and Linear Fluorescent: Provide UL-listed, low noise, Class A sound rating, high power factor, program start, NEMA premium efficiency, Class P, thermally protected with automatic reset, encased solid state energy saving ballasts for all indoor fluorescent lighting fixtures.
   a. Ballasts shall operate at a frequency between high enough to produce no visible lamp flicker and shall further be designed with an output frequency to the lamps (typically 40 kHz or greater) so as to not interfere with common infrared devices.
   b. Ballasts shall operate lamps on parallel with built-in anti-striation technology and shall deliver normal lamp life. Lamp failure shall not affect ballast life.

c. Ballasts shall comply with all applicable FCC and NEMA standards concerning EMI and RFI emissions and shall meet applicable ANSI standards related to harmonic distortion and surge suppression.
d. Ballasts shall have a minimum starting temperature of 0 degrees F and a maximum case temperature of 70 degrees C.
e. Ballasts power factor shall >95% and input current harmonic content shall be <10%. Ballast factor shall be 0.77 or 0.78 for Low Powered ballasts, 0.85 to 0.90 for Normal Powered ballasts and greater than 1.12 for High Output ballasts.
f. T8 fluorescent ballast shall be electronic, program start less than 10% total harmonic distortion rated at 50,000 starts, greater than .98 power factor for primary lamp, and .88 ballast factor.
g. Compact fluorescent ballasts shall be electronic, rated at 100,000 starts, program start less than 10% total harmonic distortion when operating at nominal line voltage of primary lamps.
h. Ballasts shall be mounted in fixtures so as to provide maximum sound attenuation. Use of 3 or 4 lamp ballasts is acceptable unless dual level switching is shown on the drawings.
i. Ballasts shall be mounted in fixtures so as to provide maximum sound attenuation.
j. Where ballasts are remote mounted from lamps, ballast packs provided shall be capable of starting and operating lamps under the lamp/ballast separation and temperature conditions encountered in the installation proposed for the project.

2. Dimming Ballasts: Wherever fluorescent fixtures are to be dimmed, the fixture supplier shall coordinate the type of dimming ballast or pack to be used with the dimming or lighting control equipment supplier to ensure compatibility. Electronic dimming ballasts and dimming packs shall be provided by the dimming or lighting control equipment supplier and factory-installed in light fixtures. Dimmed fluorescent lighting fixtures shall be provided with circuit interrupting lampholders where required for the dimming ballast or pack being used.

3. LED Drivers: Non-dimming and dimming LED drivers shall operate LEDs within the current limit specifications of the LEDs being driven.
   a. All LED drivers shall have a Class A sound rating.
   b. All LED drivers shall have less than 10% THD.
   c. LED drivers shall operate from a 60 Hz power source, have a power factor >90%, a minimum efficiency of 70% at the full rated load of the driver.
   d. LED drivers shall have integral short circuit and overload protection.
   e. LED drivers shall have a minimum starting temperature of 0 degrees F and a maximum case temperature of 70 degrees C.
   f. LED Driver output voltage shall be regulated to ±5% over the published driver load range.
   g. LED drivers shall comply with the requirements of Federal Communicartions Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
   h. Dimming drivers shall be 0-10 VDC or phase shift as noted or scheduled on the drawings. Dimming drivers shall allow light output to be maintained at the lowest control setting, prior to off, without dropping out.

4. Voltage: Ballasts and drivers for use on 120 volt systems shall be suitable and guaranteed for a voltage range of 100 to 130 volts. Ballasts and drivers for use on

277 volt systems shall be suitable and guaranteed for a voltage range of 225 to 290 volts.

5. Warranty: All ballast and LED drivers shall carry a unconditional warranty against defects in materials or workmanship, including replacement, for five years from date of manufacture including replacement for operation above the specified maximum case temperature. For LED sources and drivers, warranty shall include replacement for defects resulting in a fixture lumen depreciation >30%.
6. Disconnects: Provide quick disconnect for disconnecting all fluorescent light fixture ballasts and LED drivers per NEC.

M. Lamps:

1. General: Provide lamps of the wattage, type, color, and reflector lamps with type of beams indicated, as shown, and as scheduled.
2. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 5% (but not less than two lamps in each case) of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner's storage space.

N. Emergency Battery Backup Unit:

1. General: Provide lighting fixtures with emergency battery backup and integral emergency (self-powered) power system for each fixture as shown or scheduled on the Drawings. The integral emergency power system shall consist of a charger, high frequency inverter, voltage disconnect and a sealed nickel cadmium battery designed for high temperature operation. Provide battery unit with self test feature.
2. Operation: During normal operation, when switched ac is present, the fixture will be fully illuminated by means of the regular ballast/driver. At the same time, the emergency ballast is supplied with non-switched ac, which transforms and rectifies into a low dc voltage to recharge the battery and maintain it in a fully charged condition. When the non-switched ac fails, a solid state voltage sensor instantly turns on a high frequency inverter which illuminates one lamp in the fixture at reduced light output for a minimum of 90 minutes. At the end of the rated time a low voltage sensor disconnects the battery to prevent over discharging. When the ac non-switched returns, the inverter switches off and the battery starts recharging.
3. Battery: (Internal) Sealed Nickel Cadmium - specially constructed to withstand the high temperatures of ballast compartments. 15 year life expectancy; 5 year unconditional and additional 5 year pro rata warranty. Batteries shall not require periodic cycling or full discharge upon use to maintain full battery capacity.
4. Power Requirements: 120 or 277 volts, 60 Hz, for the specified lighting fixtures as indicated on the Lighting Fixture Schedule.
5. Output: Suitable for fixture light sources indicated at 100% of their nominal light output.
6. Transfer: Solid state-type, automatically and instantly energizes lamp load upon failure of the ac supply. Battery protection circuit automatically shuts down lamp load when battery reaches full discharge.
7. Charger: All solid state, recharges battery in 12 to 24 hours, current limited and short circuit proof.

8. Inverter: All solid state, 87% minimum efficiency uses a fully isolated and protected electronic oscillator to produce an inaudible high frequency output. Inverter will ignite lamp which has burned out under normal conditions.
9. Self-Test: The diagnostic circuit continually monitors battery voltage and charging current, and will communicate a fault by flashing the status indicator lamp. An automatic discharge test is also performed for 30 seconds, every 30 days and for 90 minutes every 12 months.
10. Enclosure: 20 gauge steel painted black baked enamel. Mounts inside the fixture adjacent to normal ballast. Flying leads provided for connections to external test switch and pilot light which is supplied with the unit. Test switch and pilot light shall be furnished to the lighting fixture manufacturer for installation and connection into the fixture by the lighting fixture manufacturer.
11. Warranty: All electronics shall carry a 3 year unconditional warranty. The manufacturer of the unit shall provide three full cycles of discharge and recharge before shipment and shall certify that the testing has been done.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the requirements and serve the intended purposes. Do not scale drawings for exact location of the lighting fixtures. In general, refer to the architectural reflected ceiling plans for proper locations of lighting fixtures. Fixtures shall exactly fit the type of ceiling system scheduled for the space.
2. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction. However, where ceiling system cannot maintain said support, fixture supports shall be provided and rigidly attached to the structural members of the building capable of carrying the weight of the fixture plus 200 pounds at each support without sagging. Provide the necessary supports for hangers located between structural members.
3. All lighting fixtures shall be grounded and bonded to the case with a green wire color and green screw originated from the panelboard.
4. All lighting fixtures that are installing butted together shall be properly grounded and bonded to the case with a green conductor wire color originated from the panelboard.
5. All lighting fixtures lenses must be clean before installing to the light fixtures.

B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of interior lighting fixtures, and with applicable portions of the NECA's "Standard of Installation".

C. Connection: All individual lay-in fluorescent fixtures in suspended ceilings, shall be connected back to the associated lighting grid outlet box by wire in 3/8" (minimum) flexible metallic conduit fixture-tails in lengths not to exceed 72"; or by Type MC cable fixture-tails

where permitted by the local authority having jurisdiction, in lengths not to exceed 8'. All fixture tails shall have ground wire pulled with conductors.

D. Mounting: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports or mounting clips for all recessed ceiling-mounted lighting fixtures in accordance with the NEC. Check to ensure that solid pendant fixtures are plumb.

E. Appurtenances: Install each fixture properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.

F. Coordination: Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.

G. Instructions: Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendations and instructions.

H. Lay-In Fixtures: Each lay-in light fixture shall be independently supported from the building structure with wires per the NEC. Fixtures shall be secured to the ceiling grid on [two] [all four] sides by clips to the webs of ceiling grid tees.

I. Continuous Row Fixtures: Rigidly align all continuous rows of lighting fixtures for true in-line appearance.

J. Pendant Fixtures: Install pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

K. Suspended Fixtures:

1. Provide means of support for luminaires per NEC 410-36. T-bar clips shall be installed on the luminaire and shall be field secured to the inverted ceiling tees so that the luminaire is securely fastened to the ceiling system framing members.
2. Ceiling tiles shall not bear the weight of luminaires. Surface mount luminaires, recessed downlights, light track, exit signs, etc. shall be supported by proper frames or other attachment to main ceiling system grid or building structure above ceiling.
3. Luminaires shall be centered in ceiling tile.
4. Luminaire shall have flange or trim ring for closure of ceiling cutout or opening.
5. Fixture studs shall be provided in all outlet boxes from which fixtures are suspended. Fixtures shall not be suspended by means of cover or canopy screws. Canopies shall completely cover the ceiling opening of all ceiling fixtures except lay-in fixtures in T-bar construction, and trimless fixtures.
6. Surface-mounted lighting fixtures (i.e. exit lights, etc.) are installed on lay-in panels in T-bar ceiling construction, the outlet boxes shall be rigidly supported to the ceiling system using metal channels spanning perpendicular across the T-bars and securely attached to each side of the outlet box.
7. Chain-suspended lighting fixtures shall be connected to the outlet box mounted directly above the fixture using flexible metallic conduit strapped to the fixture chain. Suspension chain shall be heavy duty nickel or cadmium-plated.

L. Outlet Boxes: The locations indicated for outlet boxes of lighting fixtures are diagrammatic. Outlets shall be located as required to coincide with suspension hangers where they occur and with structural and architectural elements of the building and shall be located in accordance with the Architectural Reflected Ceiling Plan.

M. Fixture Designations: If a fixture-type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Engineer before purchase and installation.

N. Installation Sequence: Do not install fixtures or such parts as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fixture finishes has been completed. Install reflector cones, baffles, aperture plates, light controlling elements for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.

O. Mechanical Rooms: Lighting fixture locations in mechanical and electrical equipment rooms are approximate. Coordinate mounting height and location of lighting fixtures to clear mechanical, electrical and plumbing equipment and to illuminate adequately meters, gauges and equipment. Support all lighting fixtures independently of ductwork, piping and their supports.

P. Concealment: Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized as necessary to conceal the outlet box.

Q. Wire Guards/Tube Guards: Wire guards or tube guards shall be provided for all fixtures with exposed lamps where installed in mechanical/electrical spaces; in all locations below 8'-0" above finished floor;] [and where lamps are exposed to damage.

R. Lighting Fixtures Installed in UL-rated Ceiling Assemblies: Fixtures shall have armored cable or flexible metallic conduit fixture-tails used for connection of lighting fixtures and shall have wiring installed as follows:

1. Shall be wired through the ends of the fixtures, or shall be provided with 90 degree ells on top of the fixtures, to allow the installation of the UL-approved fire-rated covers by the Ceiling Contractor.
2. Failure to provide the required connectors shall not relieve this Contractor of his responsibility for replacing the connectors at no additional cost to the Owner.
3. The UL fire-rated covers shall not be notched by the Ceiling Contractor because of improper wiring connectors installed on the fixtures by this Contractor.
4. This Contractor shall verify with the Architect/Engineer and the Ceiling Contractor, the specific requirements for the type of UL-rated ceiling assembly being installed.

S. Emergency Backup Units: For non-switched applications connect ac input to switched and unswitched unit inputs, unless noted otherwise on Drawings. For switched applications provide a switched ac input to the unit switched input and a non-switched ac input to the unit non-switched input.

3.02 AIMING AND ADJUSTMENT:

A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete.

B. All ladders, scaffolds, etc. required for aiming and adjustment shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjustment is completed, locking setscrews and bolts and nuts shall be tightened securely.

C. Units shall be focused during the normal working day, where possible. However, where daylight interferes with precise focusing, aiming shall be accomplished at night.

3.03 CLEANUP:

A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative. Replace blemished, damaged, or unsatisfactory fixtures as directed by Architect.

3.04 MAINTENANCE:

A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance information which shall be included in the Project Operating and Maintenance Manuals. Minimum information shall include:

1. Tools required.
2. Types of cleaners to be used.
3. Replacement parts identification list.
4. Final as-built shop drawings.

3.05 WARRANTY:

A. The Contractor shall warrant all fixtures, their finishes, and all of their component parts, except ballasts, to be free from defects for a period of one year from date of acceptance, if operated within rated voltage range. Ballasts shall be warranted for 2 years. Fixture installation shall be warranted for one year from the date of acceptance of the installation. During the warrantee period, repair or replacement of defective materials and/or repair of faulty workmanship or installation shall be provided at no cost to the Owner within 10 days of written notice of the defects as recorded and submitted by the Owner and/or Architect.

3.06 TESTING:

A. General: Upon completion of installation of lighting fixtures and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units and proceed with retesting.

B. Lamps: Fluorescent lampsand LED light sources may be utilized in the final finishing of the building. Replace lamps that are defective, show discolorations, or have exceeded more than 1/3 of their rated life, as per Engineer/Owner's records, with new lamps for final inspection.

C. Pre-Inspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation. Any fixtures or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed and replaced with properly protected metal parts.

D. Exit, Egress and Emergency Light Fixture Testing: Test all installed exit, egress and emergency lighting per NFPA Standard 101 and compliance with applicable City of Houston Ordinances to confirm that all exit, egress and emergency lighting is installed as shown on the drawings and required by the Authority Having Jurisdiction (AHJ)

END OF SECTION 26 51 00

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.02 DESCRIPTION OF WORK:

A. Work Included: The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.

B. Types: The types of lighting fixtures required for the project may include, but are not limited to:

1. LED fixtures.
2. Pole-mounted lighting fixtures.

C. Applications: The applications of lighting fixtures required for the project include, but are not limited to:

1. Exterior lighting.
2. Roadway and Parking lighting.
3. Outdoor area lighting.
4. Flood lighting.

D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

E. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.

F. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

1.03 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. NFPA 101 Life Safety Code.
2. NEMA WD1 General-Purpose Wiring Devices.

1.04 QUALITY ASSURANCE:

A. Any alternate lighting package shall be submitted and approved prior to bid. After bidding no alternate packages will be accepted. Alternate packages shall include photometric

calculations for the project including egress lighting calculations to ensure design light levels are met.

B. Manufacturers: Provide products produced by manufacturers as shown or scheduled for each type of lighting fixture. Identification in the fixture schedule by means of manufacturers' names and catalog numbers is to facilitate establishment of basic features, construction and performance standards. Any substitutions must, in the opinion of the Engineer and Lighting Consultant, meet or exceed these standards. Provide products complying with these specifications and produced by one of the following for drivers, LED light sources:

1. Light Fixtures
   a. Manufacturers as listed or scheduled on the Drawings.
2. Driver Manufacturers:
   a. Philips (Advance Transformer Company).
   b. Universal/Magnetek.
   c. Osram Sylvania.
   d. Lutron Electronics.
3. LED Light SOurces:
   a. Cree.
   b. General Electric Company.
   c. Osram Sylvania.
   d. Phillips Lighting Corporation.

C. Conformance: Fixtures shall be manufactured in strict accordance with the Drawings and Specifications.

D. Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable federal, state, and local codes and regulations.

E. UL-Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. "Standards for Safety," and others as they may be applicable. A UL-listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

F. Warranty: All LED light sources and drivers shall be provided with a 5 year warranty from the date of project acceptance.

1.05 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. Submit manufacturer's data on exterior lighting fixtures and poles in booklet form, with separate sheet for each fixture, assembled by fixture "type" in alphabetical order, with the proposed fixture and accessories clearly labeled. Driver and LED light source product data shall accompany fixture submittals.
2. Submit LM-80 lumen depreciation test results and L70 rated life test results for each type of LED source package, array or module being submitted for the project.
3. Submit dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency and visual comfort probability.
4. Submit details of fixture mounting including frames, trims, canopies, support requirements, and other data pertinent to fixture installation.

5. Submit complete photometric data for each fixture, including optical performance and efficiency rendered by independent testing laboratory developed according to methods of U.S.A. Illuminating Engineering Society as follows:
   a. For area and roadway luminaires: (1) Isocandela charts; (2) Coefficients of utilization; and (3) IES roadway distribution classification.
   b. Supply photometric data as described above for any fixture offered in substitution for a specified fixture.
6. After shop drawing approval, and prior to release for manufacturing, the Contract shall furnish one sample of each fixture on the fixture schedule and contract drawings for which sample requirement is noted. Sufficient time shall be allowed for thorough examination of the samples by the Lighting Consultant. Samples shall be complete, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to the Lighting Consultant, or as otherwise advised. Samples are not returnable, nor included in quantities listed for a project. Samples must be an actual working unit of materials to be supplied.
7. Submit details of air handling provisions for fixtures with supply and return air capabilities including, but not limited to: Airflow capacities, pressure drops, boot and connection types and other pertinent data.
8. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver exterior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.

B. Handle exterior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store exterior lighting fixtures in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS:

A. General: Provide lighting fixtures, of the size, type and rating indicated on the Lighting Fixture Schedule, complete with, but not necessarily limited to, LED light sources, reflectors, diffusers, louvers, wire guards, tube guards, drivers, fuses, and wiring. Fixtures shall be furnished with all required accessories and trim, including hold-down clips, as required for a complete installation in the ceiling-type shown on the Architectural Drawings.

1. Lighting equipment shall be complete, wired, and including supporting means
2. Lighting fixtures shall be designed for highest relative efficiency and service.
3. Lighting fixtures shall be constructed and installed in accordance with local building codes and shall bear label of approved testing agent. Materials shall be new and of best grade of approved manufacturing standards. Workmanship shall be of highest order.
4. Recessed fixtures shall be provided with frames appropriate construction encountered.
5. Ferrous fixture components shall receive treating to assure corrosion resistance and paint adherence. Aluminum parts, unless made of alloys having inherent corrosion

resistance, shall be anodized or coated with oxidation-preventing treatment. Finish shall be baked enamel where color is indicated.

6. Plastic shall be acrylic or polycarbonate.
7. All exterior light fixtures shall be UL labeled for damp or wet locations as applicable to the fixture construction and installation location.

B. General Fixture Construction:

1. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.
2. Fabricate fixture enclosures with a minimum of No. 22 gauge cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength, and acceptable to the Engineer/Lighting Consultant.
3. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion during shipping, installation, and while in normal use.
4. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.
5. All custom light fixtures shall be thoroughly tested in Manufacturer's shop prior to shipment to ensure mechanical and electrical integrity.
6. All fixtures shall be completely wired at the factory.
7. If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
8. Fixture to be sealed against light leaks between ceiling trims of recessed and semi-recessed lighting equipment and the ceilings. If fixture is used in partially transparent ceiling, fixtures to be sealed against light leaks above the ceiling line.
9. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be provided as required.
10. Fixtures for use outdoors or in areas designated as wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Damp location fixtures to be of corrosion resistant parts and hardware.
11. In the application and mounting condition specified, fixtures and drivers must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc.
12. Each lighting fixture which has a beam angle adjustment shall have reliable angle locking device capable of long and continuous use.

13. Each light fixture which has a spread lens shall contain lens orientation locking device which will insure that lens orientation is not disturbed during fixture cleaning and service.
14. All lamp sockets in lighting fixtures shall be suitable for the specified lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for the specified lamp. If different socket positions are specified for various types of the same fixture, sockets shall be preset for each type, and cartons marked accordingly.

C. Reflectors and Trims:

1. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.
2. All Ano-Brite (Alzak) parabolic cones shall be guaranteed against discoloration for a minimum of 10 years, and, in the event of premature discoloration, shall be replaced at the expense of the manufacturer for both materials and the cost of labor.
3. Aluminum reflectors shall be finished specular, semispecular, or diffuse as specified and shall meet or exceed Ano-Brite (Alzak) specifications. Minimum requirements for reflector finishes for interior and exterior service shall be as follows:

DESCRIPTION OF SERVICE	MINIMUM PERCENT OF COATING MG. PER SQUARE INCH	MINIMUM WEIGHT REFLECTANCE SPECULAR	DIFFUSE
Exterior industrial and commercial reflector not protected	10	78	75
Exterior marine service reflector not protected	13	78	65

D. Lenses:

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Dow Chemical Company (Rohn & Haas), Dupont or as acceptable to the Engineer/Lighting Consultant. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.
2. Glass used for lenses, refractors, and diffusers in incandescent and HID lighting fixtures shall be tempered for impact and heat resistance; the glass shall be crystal clear with a transmittance of not less than 88%. For exterior fixtures use tempered Borosilicate glass Corning #7740 or as acceptable to the lighting consultant. For fixtures with a radiant energy of 4.16 watts per square inch or greater, directly exposed to the elements and aimed above the horizontal, use Vycor glass.

3. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.
4. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.
5. All lenses shall be clean and free of dust at the time of substantial completion.

E. Finishes:

1. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350°F minimum, catalytically or photochemically polymerized after application.
2. White Finishes: Minimum of 85% reflectance.
3. Frames: Ceiling opening frames shall either be manufactured of nonferrous metal, or be suitably rustproofed after fabrication.
4. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.
5. Undercoat: Except for stainless steel, provide ferrous metal surfaces with a five stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.
6. Unpainted Surfaces: Unpainted nonreflecting surfaces shall be satin-finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
7. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg per square inch, of a color and surface finish as selected by the Architect.
8. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reluctance of not less than 85%.

F. Fixture Fabrication:

1. General: Design components to allow for expansion and contraction for a minimum ambient temperature range of 150°F (37.8°C) without causing buckling, excessive opening of joints or over-stressing of welds and fasteners.
2. Sheet Metal Work: Form metalwork to required shapes and sizes with true curves, lines, and angles. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of required metal. Form intersections and joints true with adequate strength and structural rigidity to prevent distortion after assembly. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners wherever possible.
3. Welding: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welded flux and dress on all exposed and contact surfaces.

4. Assembly: Accurately fit all parts of fixture. All joints in metal, not checked, shall be brazed and not soldered. Joints shall be invisible. Where screws are necessary for adjustment of applied ornament, they shall be concealed, as far as possible, and finished to match other metalwork. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration. Assembled fixtures shall be well braced, and of adequate strength to resist sagging or deforming.

G. Glass:

1. Glassware shall be mechanically strong, properly annealed, and free from internal strain that might cause breakage. Where possible glassware shall be tempered for impact and heat resistance. Unless otherwise noted, all enclosing globes shall match glass of existing fixtures, or if none exists, glassware shall match approved prototype in size, contour, finish and general appearance. Supplied globes shall faithfully reproduce existing globes or approved prototypes in every way, having qualities equal to or better than the approved prototype without sacrifice of any other characteristics such as transparency or translucency and reflection/refraction properties. Glassware supplied shall be of consistently high quality and free from such imperfections as streaks, corns, stones, blisters, checks or other flaws that affect glassware strength or appearance.
2. Dimensional Tolerances of Glass: All other dimensions of supplied globes shall not vary more than 1% more or less than the respective dimension on the approved prototype. Tolerances for glass thickness shall be set by the Architect and adhered to by the contractor. Each unit of glassware supplied shall be identical to others of that type and faithful to the approved prototype.
3. All glass ornament in relief and globes shall be blown up fully in molds so as to faithfully replicate approved samples.
4. Where shown, etch, chase or carve ornament on globes as detailed.
5. Glass Overage: Furnish 10% additional in number of each size and kind of globe (or a minimum of two, whichever is greater).

H. Wiring:

1. Generally use SF-2 insulated wire for rewiring existing or new wire at replicated light fixture. SF-1 may be substituted in those locations where space will not permit the installation of SF-2 and where the load is 6 amps or less. Provide 600 volt insulation.
2. Factory-wire all fixtures. Provide leads no shorter than 1'-0" or as required to suit the project application.

I. Connections:

1. Fasteners: Furnish fasteners of basic metal and alloy, matching finished color and texture as metal being fastened, unless otherwise indicated. For steel and aluminum fixtures, all screws, bolts, nuts, and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be bronze.
2. Welding Materials: Type and alloy of filler metal and electrolodes as recommended by producer of metal to be welded, and as required for color match, strength and compatibility in the fabricated units.

J. Fixture Types:

1. LED Fixtures: Provide LED fixtures as scheduled on the Lighting Fixture Schedule, complete with LED light sources and drivers of the type, color, wattage and size scheduled.
   a. LED Light Source Packages: LED light source packages, arrays and modules used in luminaires shall be tested in accordance with LM-80 lumen depreciation tests and shall have a L70 rated minimum life of 50,000 hours.
   b. Temperatures around driver and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.
2. Pole-mounted Lighting Fixtures: Provide pole mounted lighting fixtures and poles of the types scheduled on the Lighting Fixture Schedule. Fixture manufacturers shall be as scheduled on the Lighting Fixture Schedule. Fixtures shall be furnished with all required accessories and trim as required for a complete installation.
   a. Fixtures shall be complete with LED light sources of the type, color, wattage and size indicated on the Lighting Fixture Schedule, or as specified by the lighting fixture manufacturer.
   b. Fixtures shall be supplied with all fixture couplings and/or other accessories required by the manufacturer for proper installation to the pole.
   c. Poles shall be of the type scheduled and shall have base handholes and concealed mounting bolts, unless noted otherwise. Poles shall be installed plumb and true using leveling nuts above and below the pole base plate.
   d. Poles shall be painted to match luminaries, and shall be of the color indicated on the Lighting Fixture Schedule or as specified by the Architect.
   e. Separate in-line fuses shall be furnished and installed in each phase conductor at the pole base handhole, for each luminaire mounted on the pole. In-line fuse holders shall be Bussmann #HEB-AW-RYC, weatherproof, with insulated boots and breakaway feature, complete with Bussmann Type KTK fuses of the sizes required.
   f. Concrete pole bases shall be sized with a minimum width or diameter equal to the diameter of the pole base anchor-bolt circle plus 6", which shall provide a minimum of 3" of concrete surrounding each of the anchor bolts. The concrete bases shall have reinforcing bars provided vertically and the anchor bolts shall be set with a template and tied or welded into the vertical reinforcing bars. The concrete bases and reinforcing bars shall be as detailed on the drawings and shall be provided and installed by the General Contractor. Pole base concrete shall have a minimum 28 day strength of 2500 psi.
   g. The Electrical Contractor shall be responsible for installation of the concrete bases, and shall provide and install the lighting fixture(s), pole with handhole, anchor bolts, base cover, leveling nuts, grounding conductor, conduit and wiring, and in-line fuse(s).

K. Drivers:
1. LED Drivers: Non-dimming and dimming LED drivers shall operate LEDs within the current limit specifications of the LEDs being driven.
   a. All LED drivers shall have a Class A sound rating.
   b. All LED drivers shall have less than 10% THD.
   c. LED drivers shall operate from a 60 Hz power source, have a power factor >90%, a minimum efficiency of 70% at the full rated load of the driver.
   d. LED drivers shall have integral short circuit and overload protection.

e. LED drivers shall have a minimum starting temperature of 0 degrees F and a maximum case temperature of 70 degrees C.
f. LED Driver output voltage shall be regulated to ±5% over the published driver load range.
g. LED drivers shall comply with the requirements of Federal Communicartions Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
h. Dimming drivers shall be 0-10 VDC or phase shift as noted or scheduled on the drawings. Dimming drivers shall allow light output to be maintained at the lowest control setting, prior to off, without dropping out.

2. Voltage: Drivers for use on 120 volt systems shall be suitable and guaranteed for a voltage range of 100 to 130 volts. Drivers for use on 277 volt systems shall be suitable and guaranteed for a voltage range of 225 to 290 volts.
3. Warranty: All LED drivers shall carry a unconditional warranty against defects in materials or workmanship, including replacement, for five years from date of manufacture including replacement for operation above the specified maximum case temperature. For LED sources and drivers, warranty shall include replacement for defects resulting in a fixture lumen depreciation >30%.
   a. for the project.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the requirements and serve the intended purposes. Do not scale drawings for exact location of the lighting fixtures. In general, refer to the architectural reflected ceiling plans for proper locations of lighting fixtures. Fixtures shall exactly fit the type of ceiling system scheduled for the space.
2. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction. However, where ceiling system cannot maintain said support, fixture supports shall be provided and rigidly attached to the structural members of the building capable of carrying the weight of the fixture plus 200 pounds at each support without sagging. Provide the necessary supports for hangers located between structural members.
3. All lighting fixtures shall be grounded and bonded to the case with a green wire color and green screw originated from the panelboard.

B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of exterior lighting fixtures, and with applicable portions of the NECA's "Standard of Installation".

C. Mounting: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports or mounting clips for all recessed ceiling-mounted lighting fixtures in accordance with the NEC. Check to ensure that solid pendant fixtures are plumb.

D. Appurtenances: Install each fixture properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.

E. Coordination: Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.

F. Instructions: Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendations and instructions.

G. Surface Mount Fixtures: Install surface mounted ceiling luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

H. Wall Mounted and Pendant Fixtures: Install wall mounted and pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

I. Fixture Designations: If a fixture-type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Engineer before purchase and installation.

J. Installation Sequence: Do not install fixtures or such parts as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fixture finishes has been completed. Install reflector cones, baffles, aperture plates, light controlling elements for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.

K. Concealment: Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized as necessary to conceal the outlet box.

L. Concrete Pole Bases for Grade-mounted Installations: Branch circuit conduit for grade-mounted installations shall be routed underground into the concrete base and stubbed up with bushing into the center of the pole base. Conduit shall not be exposed on pole base. Provide 8'of bare #8 copper wire coiled at the bottom of the base in sand fill and secured to the ground lug on the pole. The length of the concrete bases below grade shall be as indicated on the Drawings or as recommended by the Architect/ Structural Engineer. Where the pole bases are installed in parking lots and along drives where exposed to vehicle traffic, the bases shall extend a minimum of 30" above finish grade. Where pole bases are installed in grass or landscape areas, (located away from the parking areas) the bases shall extend a minimum of 3" above finish grade. Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for additional requirements.

3.02 AIMING AND ADJUSTMENT:

A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete.

B. All ladders, scaffolds, etc. required for aiming and adjustment shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjustment is completed, locking setscrews and bolts and nuts shall be tightened securely.

C. Units shall be focused during the normal working day, where possible. However, where daylight interferes with precise focusing, aiming shall be accomplished at night.

3.03 CLEANUP:

A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative. Replace blemished, damaged, or unsatisfactory fixtures as directed by Architect.

3.04 MAINTENANCE:

A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance information which shall be included in the Project Operating and Maintenance Manuals. Minimum information shall include:

1. Tools required.
2. Types of cleaners to be used.
3. Replacement parts identification list.
4. Final as-built shop drawings.

3.05 WARRANTY:

A. The Contractor shall warrant all fixtures, their finishes, and all of their component parts to be free from defects for a period of one year from date of acceptance, if operated within rated voltage range. LED fixtures shall have a minimum 5 year warranty covering failure of all electrical components. Fixture installation shall be warranted for one year from the date of acceptance of the installation. During the warrantee period, repair or replacement of defective materials and/or repair of faulty workmanship or installation shall be provided at no cost to the Owner within 10 days of written notice of the defects as recorded and submitted by the Owner and/or Architect.

3.06 TESTING:

A. General: Upon completion of installation of lighting fixtures and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units and proceed with retesting.

B. Lamps: LED light sources may be utilized in the final finishing of the project.

C. Pre-inspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation. Any fixtures or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed and replaced with properly protected metal parts.

END OF SECTION 26 56 00

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 28 31 00 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. General: The extent of fire alarm system work is as shown and scheduled and includes, but is not limited to, providing a system with the following functions and operations:

1. Provide a complete distributed microprocessor based, 24 volt dc, closed circuit, electrically supervised, addressable device multiplexed fire alarm and communication system to be wired, tested, and left in first class operating condition. The system shall include, but not be limited to, a control panel with reserve standby power, voice communications system, manual alarm stations, ceiling smoke sensors, duct smoke sensors, heat sensors, addressable input and output devices, sprinkler waterflow switches, valve supervisory switches, audible and visual alarm indicating devices, raceways, wiring and all hardware and software as required to effect an operational system as herein specified. Each alarm device shall be individually addressable.
2. The system shall operate as a non-coded, continuous sounding system which will sound alarm devices until manually silenced, as herein specified.
3. The system shall be wired as a Style 4 for the Signaling Line Circuit (SLC) and a Style Y for the notification appliance circuit.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the latest edition of the following standards:

1. National Fire Protection Association Standards:
   a. NFPA 70 National Electrical Code.
   b. NFPA 72 National Fire Alarm and Signaling Code.
   c. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
   d. NFPA 13 Installation of Sprinkler Systems.

2. Underwriters' Laboratories, Inc. Requirements and Listing for use in Fire Protective Signaling Systems as follows:
   a. UL 864 Control Units and Accessories.
   b. UL 268 Smoke Detectors - Systems.
   c. UL 268A Duct Smoke Detectors.
   d. UL 217 Smoke Alarms.
   e. UL 521 Heat Detectors.
   f. UL 228 Door Holders - Closers.
   g. UL 464 Audible Signaling Devices.
   h. UL 1638 Visual Signaling Devices.
   i. UL 38 Manual Signaling Boxes.
   j. UL UOJZ Control Units.
3. City of Houston and the requirements of state and local authorities having jurisdiction.
4. Comply with requirements of the Americans with Disabilities Act of 1990.
5. Comply with the requirements of the Texas Accessibility Standards (TAS).

1.4 QUALITY ASSURANCE:

A. Manufacturers: The equipment specified herein is that of the Notifier Fire Systems, and constitutes the style of operation, quality of construction, features and physical size limitations required for this project. A fire alarm system from Firelite by Honeywell in compliance with these specifications and drawings will be considered an equal manufacturer.

B. UL and FM-listing: All fire alarm system components shall be UL and FM listed for fire alarm use. The UL listing shall be under category UOJZ to assure that the entire system has been tested as an integral life safety system.

C. All equipment furnished shall be the current standard products of a single manufacturer and shall bear the label of the Underwriters' Laboratories for use in fire alarm system designed in compliance with the requirements of NFPA codes. Raceways, wiring and terminations shall be accomplished in compliance with the requirements of the National Electric Code, Article 760, except that all wiring shall be in EMT or an approved raceway.

D. The system as installed shall, upon completion, be certified by a state licensed fire alarm installation superintendent to the Owner as being installed in compliance with the specification, the requirements of all state and local codes, and as being operational and free from defects.

E. All system equipment supplied shall be listed by the Underwriters' Laboratories for NFPA 72 system use, and all applicable NFPA Codes.

F. The installing contractor shall be authorized and designated representative of the fire alarm system manufacturer to sell, install and service the manufacturer's equipment and shall stock the required spare parts to keep the system in operation. The installing contractor shall maintain a staff of specialists for technical assistance and system maintenance.

G. The installing contractor must be licensed by the State Fire Marshal to sell, install, and service fire alarm system as required by Article 5.43-2 of the Texas Insurance Code.

H. The installing contractor shall have on his staff a minimum of five installation superintendents who are licensed by the State Fire Marshal's office for such purpose and under whose supervision installation, final connections and check out will take place, as required by the Texas Insurance Code.

I. The installing contractor or equipment supplier shall have a staff a minimum of one certified NICET Level II state licensed fire alarm planner under whose supervision system design shall take place.

J. The equipment supplier shall provide 24 hour, 365 days per year emergency service with qualified and state-licensed service technicians.

K. The installing contractor shall have been actively engaged in the business of selling, installing, and servicing microprocessor and multiplex fire alarm systems for at least 10 years and shall have proof of experience in the installation and maintenance of the type of fire alarm system specified herein.

L. The manufacturer or his representative shall maintain within 100 miles of the installation, a staff of factory trained, state licensed fire technicians, together with all support parts necessary for maintenance of the system.

M. Where approved in writing by the system manufacturer and installing contractor, the Electrical Contractor may install all conduit and boxes. The system wiring shall be pulled in by the installing contractor. All system connections, device installation, system start-up and testing shall be performed by the installing contractor. Rough-in by the electrical contractor shall not in any way affect the system manufacturer's and installing contractor's full responsibility for the installed fire alarm system.

N. The manufacturer shall submit legal documentation indicating that the purchased fire alarm equipment will be provided with parts, and support for 10 years after the acceptance by the Owner.

O. Plenum cables are not acceptable unless written authorization is given by the Engineer. All wiring shall be listed for limited energy fire alarm use and rated for 300 volts minimum.

P. The complete combination fire alarm system shall comply with the City of [Houston] Building and Fire codes. Modifications required to provide compliance shall be made at no cost to the Owner. Where Contract Document requirements are in excess of Code requirements are permitted under the Code, the Contract Documents shall govern.

1.5 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. A written description of the system operation (written in this specification format), with all exception and/or deviations clearly highlighted or identified.
2. A block diagram showing system components, wire runs, wire counts and wire sizes.
3. A control panel layout diagram showing the location of all modules and wiring and interconnection schematics.
4. Calculations justifying battery size, power supply size, amplifier size, and wiring sizes based on worst case occurrence.
5. Manufacturer's descriptive literature for all panels, modules and peripheral equipment describing size, color, finish, capacity and electrical characteristics.
6. A complete listing of all associated software showing the relationship of alarm points, control outputs, control inputs and indicators.
7. An alarm matrix showing alarm and control function for an alarm in each device/zone.
8. Scaled floor plan drawings locating and naming each device/zone and showing wiring and conduit sizes from each device back to the transponders.
9. A complete riser/wiring diagram showing zoning and addressing and wiring and conduit sizes from the CPU to all remote terminal units, graphics terminals, flat panel displays, printers, and other system devices.
10. Completely identified and marked catalog cuts of all associated equipment and devices, with all non-applicable items crossed out, or applicable devices clearly highlighted and/or identified.
11. Complete and detailed point-to-point wiring diagrams for all devices in the system.
12. Complete Bill of Material for all equipment.
13. A printout showing the proposed custom software messages for each device/zone and for each control function.
14. A copy of the form to be used for final tests, 100% audit and checkout shall be submitted for approval.
15. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver fire alarm system components in factory-fabricated containers.

B. Store in a clean, dry space and protect from the weather.

C. Handle control and annunciator panels carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: Provide the required fire alarm system products in the sizes and capacities required or indicated, complying with the manufacturer's published product information of standard materials and components, designed and constructed for the applications indicated.

2.2 SYSTEM OPERATION:

A. Activation of an "intelligent" smoke detector shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. When an "intelligent" smoke detector senses an abnormal level of smoke, the loop interface module shall automatically initiate a "check" mode. Four consecutive samples shall be made of the prospective detector. Upon completion of four consecutive smoke trouble conditions, the detector is considered "checked" and the system goes directly into an alarm mode, unless the verification mode is activated for the detector.
2. Alarm verification shall be programmable by detector(s) to initiate a verification sequence after the "check" procedure and the Fire Alarm Control Panel shall wait a field-programmable delay period (0 to 50 seconds), and then proceed to resample the detector four more times for continued presence of smoke. If three or more samples verify an alarm condition still exists, the system will then initiate all alarm sequences specified herein. Less than three consecutive samples during the verification cycle will NOT result in a system alarm condition. The system shall incorporate the ability to log in memory the number of verification events that have occurred for each selected device.
3. The system common alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state.
4. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location and time of alarm. Location and zoning messages shall be custom field-programmed to respective premises.
5. Appropriate status change message(s) shall be transmitted to all annunciators, graphics terminals, CRT displays and printers and an alarm shall be transmitted to a remote Central Station.
6. Activate all audible alarm zones on the floor of alarm, the floor above and the floor below with a prerecorded alarm message.
7. Flash all visual alarm signal zones on the floor of alarm, the floor above and the floor below.
8. Activate addressable output relays to unlock all locked security doors.
9. Activate addressable output relays to unlock electric door strikes at the Fire Command Center.

B. Activation of any addressable manual pull station, [beam smoke detector,] sprinkler waterflow switch or "intelligent" heat detector shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. Cause all operations and indications described in Paragraph 2.03/A.3 through 2.03/A.9 to occur.

C. Air handling units shall be shutdown via addressable output relay whenever the unit duct smoke detector is activated or the building smoke exhaust system on the floor served by the unit is activated.

D. Closure of a supervised OS&Y or PIV valve sensed via a supervisory switch or loss of supervisory air pressure in a dry-pipe sprinkler system, sensed via a pressure switch shall cause the following operations and indications:

1. The system common alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state.

2. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location, and time of alarm. Location and zoning messages shall be custom field-programmed to respective premises.

3. Appropriate status change message(s) shall be transmitted to all graphics terminals, CRT displays, and printers.

E. All Fire Suppression Systems shall be monitored by the fire alarm system for first alarm, discharge alarm and a common trouble alarm. The presence of an alarm or trouble condition shall cause the following operations and indications:

1. Cause all operations and indications described in Paragraph 2.03/A.3 through 2.03/A.9 to occur.

F. Dry pipe or Preaction Suppression System shall be monitored by the fire alarm system for alarm pressure, high/low air pressure and valve shut off.

1. Alarm pressure shall cause all operations and indications described in Paragraph 2.03/A.3 through 2.03/A.9 to occur.

G. Fire Pump Controllers shall be monitored by the fire alarm system for fire pump run, fire pump phase reversal (electric pumps only), fire pump loss of power, fire pump low pressure and fire pump isolating switch open. The presence of an alarm or trouble condition shall cause the following operations and indications.

1. The system common alarm or trouble LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm or trouble condition shall silence the audible trouble device and revert the flashing common alarm or trouble LED to a steady state.

2. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm or trouble condition including: zone, device type, device location, and time of alarm or trouble. Location and zoning messages shall be custom field-programmed to respective premises.

3. Appropriate status change message(s) shall be transmitted to all annunciators, graphics terminals, CRT displays, and printers.

H. The presence of a ground condition or an open circuit on any alarm initiation circuit or a ground condition, open circuit or short circuit on any alarm indicating circuit, blockage, lens contamination or physical misalignment of any beam type smoke detector, a trouble condition at a fire suppression system panel or other trouble condition shall cause the following actions and indications:

1. The system common trouble LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the trouble condition shall silence the audible trouble device and revert the flashing common trouble LED to a steady state.

2. An alpha-numeric LCD Display shall indicate all applicable information associated with the trouble condition and its location. System trouble diagnostics shall assist in defining the trouble condition. Unacknowledged alarms/messages shall have priority over any trouble displays and take precedence on the LCD annunciator. Trouble conditions will be stored in memory for future recall/ display.

3. Appropriate status change message(s) shall be transmitted to all annunciators, graphics terminals, CRT displays, and printers.

I. All designated "nonsilenceable" auxiliary control functions shall remain in operation (even upon silencing of audible alarms) until such time as the control panel is cleared and reset manually (i.e. fan control outputs, central station interface, elevator recall interface, etc.).

J. Provisions shall be included within the Fire Alarm Control Panel for the following manual controls in addition to those previously mentioned:

1. Disconnect audible signalling while testing.

2. Temporary software bypass of selected alarm points.

3. Software assignment of selected alarm points to alarm verification function as a method of tracking alarms caused by environmental factors or maintenance requirements. Waterflow switches, smoke detectors, and valve supervisory switches shall be assigned to the verification group to eliminate nuisance alarms.

2.3 SYSTEM DEVICES:

A. System devices shall be located as shown on the Drawings. The Contractor shall refer to all the drawings to determine where devices are to be located. All system devices shall be numbered with a unique number. The numbering system shall include the building area, type of device, and device number. This numbering system shall be shown on each submitted

floor plan drawing, fire alarm riser diagram and be tabulated. The tabulation shall be included in each O&M Manual submitted to the Owner.

2.4 SYSTEM ZONING:

A. The system shall employ "intelligent" heat and smoke detectors and addressable interface devices capable of being recognized and annunciated at the main control panel, system printer and graphic terminal on an individual basis. All devices shall be field-programmed into software zones for the purpose of general area identification and annunciation. However, each device shall also be annunciate identified on an individual basis including exact location and device type. All zoning/device location information shall be totally field-programmable to exact job requirements. Devices shall be zoned as follows:

1. Manual pull stations, area smoke and heat detectors and sprinkler water flow and pressure switches shall be zoned by floor and device.
2. Elevator lobby, machine room and shaft smoke detectors shall be zoned by elevator group and device.
3. HVAC equipment supply air and return air smoke detectors shall be zoned by device.
4. Fire suppression system(s), kitchen hood fire suppression system, fire pump monitoring and similar functions shall each be zoned separately.

B. Initiating and monitored devices shall include, but not be limited to, the following:

1. Manual pull stations.
2. Ceiling smoke detectors.
3. Duct smoke detectors.
4. Ceiling heat detectors.
5. Addressable input devices.
6. Sprinkler flow and pressure switches.
7. Valve supervisory switches.
8. Fire suppression system panels.

C. The system shall utilize remote transponder panels for distributed voice communications and auxiliary control output circuits. Remote transponder panels shall communicate with the main CPU via the SLC data loop and be capable of being intermixed on the same loop as intelligent heat and smoke detection and control modules.

D. Output devices shall include, but not be limited to, the following:

1. Wall and ceiling alarm speakers.
2. Wall and ceiling alarm speakers/visual signals.
3. Wall and ceiling Visual alarm devices.
4. Addressable interface relays.

5. Magnetic door holders.

6. Graphics terminals, flat panel displays, and printers.

2.5 SYSTEM CONFIGURATION:

A. System equipment shall include, but not be limited to an operator's control/system control panel, remote transponder panels, high resolution VGA color monitor(s), graphic and system printers, voice paging panel, firefighter's HVAC override, battery back up, alarm indicating devices, door hold opens and output relays and other devices required to provide a complete and working system.

B. The system control unit shall be connected to remote transponder panels on a looped signaling line circuit. The wiring of the loop shall be so arranged that additional transponder panels may be inserted in the loop without requiring additional wires to be installed between transponder panel and the system control unit. In additional, loops shall be so arranged that any wiring fault on a loop shall not disable more than 250 initiating devices. A single open ground or multiple opens in different wires at the same location shall not prevent receipt of alarm signals from that loop.

C. The system shall be of the active multiplex/addressable type wherein each initiating device shall be repetitively scanned, causing a signal to e transmitted to the control unit that indicates the individual initiating device circuit installation wires are intact. Loss of such a signal at the system control unit shall resulting a trouble indication as specified hereinafter for the particular indicating device affected. All indicating devices in the system shall transmit their normal, trouble or actuated status signals in no less than 5 second intervals.

D. Each individual smoke detector shall be of the analog type so that the system can be used to read smoke levels on a real time basis from selected smoke detectors for maintenance and diagnostic purposes. All smoke detectors and other initiating devices shall be individually indicated at the main control panel, the color graphics unit and each transponder panel, when changing to an alarm or trouble state.

2.6 FIRE ALARM SYSTEM CENTRAL EQUIPMENT:

A. General: The Fire Alarm Control Panel shall be Notifier NFS2-3030 or approved equal. The control panel shall be modular in design utilizing distributed solid state microprocessors and be capable of future expansion. The microprocessor-based CPU shall be completely field-programmable. CPU module shall provide for programmable nonvolatile RAM memory utilizing integral lithium-based memory IC chips. Each panel module shall be independent employing its own microprocessor circuitry for reliability and independent operation in case of main CPU failure. The system control unit shall have capacity for the required active detection and output points with space for future use and expansion. The control unit shall be listed to the latest UL 864 Standard. All circuitry shall be UL listed for power-limited application and use positive temperature coefficient devices for current limiting. The panel shall be provided with keylock hinged door to access system controls/switches. The panel door shall be provided with a transparent window for viewing all alarm, trouble indicators, and LCD annunciator. The control unit shall be designed for [flush] [surface]-mounting.

B. Central Processing Unit Module (CPU): The CPU shall communicate with monitor and control all other modules in the panel via internal serial communications techniques.

1. Removal, disconnection, or failure of any control panel module shall be detected and reported by the CPU.
2. The CPU shall contain and execute all custom control-by-event programs for specified events if a fire situation is detected in the system. Such programs shall be held in nonvolatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The CPU module shall contain a real-time clock circuit to time/date stamp system events and execute custom time control programs. Time control program events shall be terminated in a fire conditions.

C. Display Interface Board (DIA): The DIA shall provide all touchpad controls and indicators used by the system operator and may also be used to program all control panel and system parameters.

1. The DIA shall contain, and display, custom alphanumeric labels for all intelligent detectors and addressable modules. Such label information shall be stored in field-programmable nonvolatile memory.
2. The DIA shall provide an 160 character alphanumeric Liquid Crystal Display (LCD).
3. The DIA shall provide five Light-Emitting Diodes (LEDs) for ac power, system alarm, system trouble, display trouble, and disable.
4. The DIA shall provide a 25 key membrane keypad with control capability to command all system functions, status readouts, manual control action, and entry of any alphabetic or numeric information. The keypad shall include means to enter two different five digit passwords to prevent unauthorized manual control or programming.

D. Loop Interface Board (LIB): LIB's shall be provided to monitor and control each loop of intelligent detectors and addressable modules.

1. The LIB shall contain its own independent microprocessor control and shall be capable of alarm detection and automatic control action on its own loop even if a failure occurs in the system central processor unit, internal connections, or other modules.
2. The LIB shall communicate and provide power to all devices on its Style 4 loop over a single pair of wires. For dynamic Style 4 supervision the loop may be branch-circuited or "t-tap" connections may be made off of the loop. Loop wiring shall be twisted shielded pair of up to 10,000' in length.
3. The LIB shall receive digital/analog information from all "intelligent" detectors and shall process this information to determine normal, alarm, trouble and sensitivity conditions.

The analog information shall also be used for automatic test and determination of maintenance requirements.

4. The LIB module shall individually monitor all "intelligent" detectors for sensitivity variation initiating a trouble condition should detector sensitivity "drift" toward either threshold of false alarming or nonalarming conditions. In addition, the system shall have the capability to read each detector's sensitivity, and if need be, electronically adjust the detector sensitivity as required for existing conditions within UL-recommended limits.
5. The LIB shall communicate continuously with each "intelligent" detector, remote transponder and addressable module on its loop and verify its proper function and individual status. Communication with up to 198 such devices per loop shall be performed every 6 seconds or less.

E. Control Switches: Provide the following control switches at the Fire Alarm Control Panel.

1. Acknowledge switch.
2. Signal silence switch.
3. System reset switch.
4. System test switch.
5. Lamp test.

F. Nonlock Walk Test: The system shall include a special nonlock "walk test" mode where each initiating device is manually placed in alarm. The control panel pulses the system audible devices on detection of each such alarm and automatically resets the panel, permitting a single serviceman to functionally test the entire system.

G. Automatic Detector Test: The system shall include a special automatic detector test features which permits reading and adjustment of the sensitivity of all intelligent detectors from the main control panel. In addition, the automatic test feature shall also permit the functional testing of any "intelligent" detector or addressable interface device individually or by zone from the main control panel. Results of the test are then indicated on the LCD display. A printout of all test data shall be capable via the system printer.

H. Special System Reports: The system shall have the ability to generate and print, upon command, system and point status reports.

1. Selection of "system" read status provides the operator with global system programming information including: alarm verification, SLC loop styles, number of SLC loops, number of software zones, number of auxiliary power supplies, signal silence inhibit.
2. Selection of "point" read status provides the operator with selected individual point programming data including: point status (normal, alarm, trouble, disabled, etc.), address, type I.D., control by event, custom alphanumeric label, verification status, alarm threshold level, sensitivity, silenceable/ nonsilenceable, SLC loop number, and device number.

I. System Diagnostics: The system shall include special software to detect, diagnose, and report failures and isolate such failures to a printed circuit board level.

1. Each module via its resident, independent processor shall periodically perform independent self-test routines as a self-operational/performance test. Any irregularities are reported via the LCD display and trouble indicators.
2. A lamp test function shall be provided to test all system indicators including the LCD display. This function shall also test the panel trouble device for proper operation.
3. A keypad test function shall also be provided allowing the user to interactively confirm that all keys are functional and operating correctly.
4. The system shall include independent "Watch-Dog" timer software to detect and report failure of any microprocessor circuit, memory, or software. The function of this safe-guard software/circuitry is to then restart the respective processor and maintain proper operation of the system. In addition, the master CPU has control over a hardwired reset terminal which can perform a system-wide restart.

J. Field Programming: The system shall be 100% field-programmable without the need for external computers, or PROM programmers, and shall not require replacement of memory ICs. Systems requiring factory-programming/reprogramming or replacement of memory IC chips shall NOT be acceptable.

1. All programming may be accomplished through the front control panel indicators and switches or via a lap top computer.
2. All programs shall be stored in nonvolatile RAM memory.
3. Programming shall be accomplished only after entering an appropriate and preselected five digit password security code.
4. All programming functions shall be initiated via special system "prompting" menus via the system main CPU. The system shall be capable of direct English language programming and prompting and not require complex digital equations or special formulations.
5. The system shall provide a means to "review" all programmed functions.
6. The system shall be capable of revising/changing programmed functions or system expansion at anytime subsequent to initialization as described herein without factory-modifications or factory-reprogramming.
7. Any addressable indicating circuit or auxiliary addressable relay shall be programmed to activate on alarm of a single initiating device or a combination of initiating devices.

K. Event History: The main fire alarm panel shall have the resident ability to store a minimum of 600 system events in chronological order of occurrence.

1. Event history shall include all system alarms, troubles, operator actions (i.e. acknowledge, silence, reset, program entry, etc.), unverified alarms, circuit/point alterations, component failures.
2. Events shall be time and date stamped and be capable of being recorded and/or reviewed without purging the history file.
3. Events shall be stored in non-volatile buffer memory. Access to history buffer shall be secured via five digit password security code.
4. Event recording shall automatically overwrite the oldest event(s) in memory beyond the initial 600 events.
5. Systems not employing event history memory storage shall be required to furnish a printer/recorder for recording system events.

L. Power Supply: The power supply for the panel and all fire alarm peripherals shall be integral to the control panel.

1. The power supply shall provide all control panel and peripheral power needs with filtered power as well as 3 amperes of regulated 24 volt dc power for external audio/visual devices. The audio/visual power may be increased as needed by adding additional modular expansion power supplies.
2. All power supplies shall be designed to meet UL and NFPA requirements for power-limited operation on all external signaling lines, including initiating circuits and indicating circuits.
3. All circuitry shall be UL listed for power-limited application and use positive temperature coefficient devices for current limiting. Fuses or other thermal overload type protection shall be unacceptable.
4. The system shall derive its primary operating power from a 120 volt ac, single phase, 60 Hz supply. There shall also be a 24 volt battery standby power source with internally supervised batteries and automatic charger, capable of operating the entire system for a minimum of 8 hours in the supervisory mode and then be capable of operating the alarm devices for a minimum of 20 minutes.
5. The power supply unit shall contain suitable overvoltage protection to prevent any malfunction or damage which might occur from line power surges (lightning).
6. Upon loss of main power, the power supply unit shall automatically revert to battery power and the system shall remain fully operational.
7. When the ac power is restored, the control unit shall automatically revert to normal operation without requiring any manual restarting procedures.
8. The battery shall be automatically charged by a built-in short-circuit-proof charger.
9. The charging current shall be automatically controlled according to the battery's ambient temperature.

10. After a full discharge, the system shall be able to recharge the batteries completely within 12 hours.
11. The connection to the battery shall be automatically switched off when the voltage drops below 19 volts to protect battery cells from damage to deep discharge.
12. Sealed lead acid batteries shall be used for emergency power source.
13. The entire power supply charger circuits including fuses shall be supervised both positive and negative ground fault supervision, battery/charger fail condition, ac power fail indicators. The power supply shall also provide supervision of modular expansion power supplies as may be required. Any malfunction, or blown or missing fuses shall result in a fault indication on the control unit.

2.7 VOICE COMMUNICATION PANEL:

A. General: The Notifier DVC digital voice communications panel shall be modular in design utilizing solid state microprocessor circuitry and be capable of future expansion. The control panel shall be of dead front construction and have specified communications circuits with space for future use and expansion. The primary voice communications panel is existing to remain.

B. Communications Controls: The communications control panel shall incorporate the following controls and indicators:

1. All call select switch with LED indicator.
2. General alarm select switch with LED indicator.
3. Audio trouble LED indicator.
4. Audio level LED indicator.
5. Manual tone/message select switches with LED indicators.
6. Communications pilot/status LED indicator.
7. Telephone remote page selector.
8. Communication zone select switches with LED select indicators.
9. Communications monitor speaker with volume control.
10. Dynamic paging microphone.

C. Paging:

1. The microprocessor based one way paging system shall be provided with a means to selectively and simultaneously activate voice, tones or digitized messages to any or all zones in the system via electronic membrane touchpad controls. In addition, visual indication by zone will be provided for zones selected.
2. Each audio/speaker circuit will be totally supervised for opens, shorts or grounds with direct shorts prohibiting selection of the respective zone.

3. All audio circuits shall be power limited per the latest UL and NEC Standards.
4. All speaker circuits shall be wired in parallel.
5. Each speaker zone shall be provided with an amber trouble LED for circuit trouble conditions and an active/on LED indicator.
6. Alarm/Paging zones shall be provided as follows:
   a. One zone for each building level.
   b. One zone each for garage level.
   c. One zone for each stairwell.
   d. One zone for each elevator bank (to include all elevator cabs in respective bank).
   e. One zone for Central Plant.

D. Communication Electronics:

1. The voice communications center shall be a microprocessor based, supervised, multi-function, audio generator. The communications generator shall contain:
   a. Voice communications CPU.
   b. Nonvolatile RAM memory.
   c. Communications configuration dip switches.
   d. Two custom digitized message circuits.
   e. Up to four selectable tone generator/oscillators.
2. Each sub-circuit of the communications center shall be fully supervised and failure of any tone oscillator or digital message generator shall revert the system to the default standby generator. Any system/sub-system failure shall be indicated audibly and visually by a system trouble condition.
3. The system shall have the ability to provide any combination of standard digitized factory programmed messages, custom field programmable digitized messages, and/or alarm tones. Capability for multiple messages shall be standard with messages capable of being selected manually and/or via control-by-event program. Custom message programming shall be capable of being performed at the main fire alarm communications panel and without the need of special programming/recording apparatus or off site programming. Mechanical tape decks/drives shall not be deemed acceptable.

E. Amplifiers:

1. The system shall provide distributed amplification via the system remote transponders. The system shall be capable of amplifier expansion capacity as required.
2. Each amplifier shall be continuously monitored electronically for proper output level. Each amplifier shall be capable of being properly adjusted for correct output level.

3. Each unit shall be equipped with NORMAL level LED and ABNORMAL level LED diagnostic indicators.
4. Each amplifier shall provide 75 watts of 25 VRMS power and be capable of being assigned to one or more audible circuits.
5. Each unit shall be equipped with its own individual power/pilot LED, audio input trouble LED, battery input trouble LED, and amplifier trouble/fail LED. Any fault or trouble condition shall be annunciated audibly and visually via a system trouble condition.
6. The system shall provide automatic standby amplification for any amplifier in the system. Transfer from any faulty amplifier to the standby unit shall be fully automatic.

F. Alarm Tone: The fire alarm alert tone shall be a slow whoop tone with standby default tone in the event the primary oscillator fails. Transfer to default tone oscillator shall be automatic upon primary oscillator failure. Transfer to default tone shall also be automatic upon failure of any digitized voice message.

2.8 REMOTE TRANSPONDER PANELS:

A. Remote transponder/control panels shall be distributed remotely throughout the facility as required and as indicated on the Drawings. Transponders shall provide input/output interface between all field devices/equipment and main system CPU.

B. All functions of the transponder unit(s) shall be field-programmable via the main system CPU and incorporate nonvolatile RAM memory. Each unit shall be capable of operating independently in default mode should communication with the main CPU be disrupted. Transponders shall be capable of operating on the system SLC intelligent loop in conjunction with intelligent field devices.

C. The transponder shall include a resident microprocessor based CPU control module interfacing the main system CPU with respective I/O modules served by the resident/local CPU. The local CPU shall provide each transponder with common status indicators, pilot/status LED, common alarm LED, and common trouble LED. Each CPU module shall include local silence, reset, trouble display, lamp test, and reset capability. Each control module shall provide dual Form C common alarm and trouble contacts as well as a local alarm/trouble Piezo sounder.

D. Each transponder shall be capable of providing audio power supervision/annunciation, power supply supervision/annunciation, and supervision of all associated I/O modules. Each transponder shall be field programmable for alarm verification. Selection of alarm verification shall provide each associated zone/ input module with the automatic ability to verify all smoke detector initiated alarm signals before initiating any event initiated output functions. The system shall have the ability to electronically differentiate between smoke detector alarms and contact/shorting device alarms and will NOT allow the verification sequence to occur from signals initiated from pull stations, flow switches, heat sensors, etc.

E. All transponder mapping/addressing shall be accomplished via the transponder CPU module.

F. Transponders shall be provided with auxiliary output/control relay modules as required. Each module shall provide eight SPDT (or four DPDT) field programmable output circuits. Output circuits shall be power limited. Each output shall be rated at 2 amps, 24 volts dc. Each circuit shall assume a designated and distinct address I.D. within the system and be field programmable for control by event actuation. Designated control circuits shall be provided with software assignable manual control switch as herein specified. The transponder shall monitor the status of each output module and associated circuit for normal, activated, and trouble conditions. Each circuit shall be equipped with an individual status LED indicator.

G. The power supply for the panel and all fire alarm peripherals shall be integral to the control panel. The power supply shall provide all control panel and peripheral power needs with filtered power as well as 3.5 amperes of unregulated 24 volt dc power for external audio/visual devices. The audio/visual power may be increased as needed by adding additional modular expansion power supplies. All power supplies shall be designed to meet UL and NFPA requirements for power-limited operation on all external signaling lines, including initiating circuits and indicating circuits. All circuitry shall be UL listed for power-limited application.

H. Input power shall be 120 volt ac, 60 Hz. The power supply shall provide internal supervised batteries and automatic charger. The power supply shall provide both positive and negative ground fault supervision, battery/charger fail condition, ac power fail indicators.

I. Transponder shall be housed in key-locked steel cabinet painted in baked enamel finish. Cabinet door shall provide transparent glass window for viewing transponder indicators and controls. The cabinets shall be no more than 5" deep and 24" wide to conserve space. Cabinets shall be provided with conduit knockouts on sides and top for versatility in installation. The cabinet(s) shall be capable of accommodating multiple transponder units in a single enclosure.

2.9 REMOTE ANNUNCIATORS:

A. Serial Annunciators: Notifier Model LCD-160 or approved equal supervised remote LED annunciators shall be provided where indicated on the Drawings.

1. Annunciators shall be field-programmable to annunciate selected given points and/or zones. Annunciators shall be field-configured as a remote system control and annunciator unit or as a "receive only" unit.

2. Each annunciator shall provide 160 character display similar to the main fire alarm panel.

3. Each remote annunciator shall also contain a local alarm/trouble Piezo sounder and acknowledge/ lamp test switch. Each unit shall contain a common trouble LED and on line/pilot LED indicators. Zone LED indicators shall flash upon receipt of alarm (or trouble) conditions and revert to steady state upon system or annunciator acknowledgment. Local sounder shall silence upon acknowledgment.

4. The system primary remote annunciator shall duplicate system control capability as follows: System acknowledge/trouble silence, signal silence, lamp test, system reset, signal silence LED, and system alarm and trouble LED's.

B. Graphic Annunciator: Notifier Auto-Plexor 2020 or approved equal microprocessor remote graphic annunciators shall be provided where indicated on the Drawings.

1. The annunciator shall provide a custom graphic multicolor mylar layout of the building area and be back-lit with multicolored alarm LED indicators. Upon an alarm condition, appropriate LED illumination shall indicate from which area/zone the alarm was initiated. The annunciator shall also be provided with common alarm, common trouble and power pilot LED's. The annunciator shall contain an integral alarm/trouble buzzer with associated silence switch.

2. The remote graphic annunciator shall communicate with the main fire alarm control unit CPU via a standard RS-232 interface port.

3. The annunciator shall be custom-programmed to display any alarm and/or trouble conditions from selected point(s). The unit shall have field-selectable multibaud rates and operate at 5 MHZ with no wait state. Internal microprocessor shall be supervised.

4. Each annunciator shall come equipped with integral alarm/trouble sonalert with silence switch and lamp test switch.

2.10 SMOKE AND HEAT SENSORS/DETECTORS:

A. Intelligent "Ceiling-mounted" Multi Criteria Smoke Sensors: Notifier Model FPTI-951 or approved equal analog multi criteria smoke sensors shall be provided where indicated on the Drawings.

1. The intelligent multi criteria smoke sensors shall connect via two wires to one of the intelligent control panel loops.

2. The multi criteria sensors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Each sensor shall also have a built-in heat and infrared detector.

3. The sensors/control panel shall provide automatic sensitivity "drift" compensation to provide longer term stability and reliability. The sensor shall also provide a "maintenance alert" feature whereby the detector shall initiate a trouble condition should the units sensitivity approach the outside limits of the normal sensitivity window.

4. The sensor shall be provided with extensive RF and EMF noise reduction circuitry.

5. The sensor shall employ sophisticated self-compensating solid state LED light source and photosensitive circuitry.

6. The sensor/control panel shall provide a calibrated test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test

may be initiated at the detector itself, by activating a magnetic test switch, or may be activated remotely on command from the control panel.

7. The sensors shall provide address-setting means on the sensor head using rotary decimal switches. No binary coding shall be required. The sensors shall also store an internal identification code which the control panel shall use to identify the type of sensor.

8. The sensors shall provide dual alarm and power/status LEDs. Status LEDs shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected and verified. An output connection shall be provided in the base for connecting an external remote alarm LED.

9. The sensor shall be semiflush ceiling-mounted and be provided with modular detector head with twist-lock base. Sensors shall also be suitable for surface-mounting below the raised floor or above the ceiling. Sensors shall be provided in smooth attractive white finish, and sealed against dirt, vermin, and back pressure. Sensors shall be provided with fine mesh insect/contaminate screen.

10. Sensors shall be UL listed with respective control panel.

B. Intelligent "Duct Mounted" Photoelectric Smoke Sensors: Notifier Model DNR Series duct-mounted intelligent photoelectric smoke sensor shall be provided where shown on the Drawings.

1. Sensors shall operate on the same principles and exhibit the same basic characteristics as area type "intelligent" smoke sensors. The unit shall be capable of interchanging/accepting either photoelectronic or ionization type sensors.

2. The sensor shall operate in air velocities of 300 FPM to 4,000 FPM without adverse effects in detector sensitivity.

3. Each sensor shall operate directly with the intelligent control panel loop, without an interface module.

4. The unit shall consist of a Noryl molded plastic enclosure with molded integral conduit knock-outs. The unit shall be provided with clear faceplate cover to provide visual viewing of detector/sensor for monitoring sensor operation and chamber condition. The duct housing shall be provided with gasket seals to provide proper sealing of housing to mechanical ductwork and to ensure proper air flow into the detector sampling chamber. Duct housing shall be designed to easily mount to rectangular or round ducts.

5. The duct sensor unit shall be UL listed to the most current UL 268A standard and be cross-listed for use with the fire alarm control panel.

6. Each duct sensor unit shall be equipped with sampling tubes protruding into the associated ductwork. Sampling tubes shall extend the width of the duct. Sampling

tubes shall be provided with integral porosity filter system to aid in reducing detector contamination. Sensors shall be installed per NFPA 90A.

7. Duct sensors shall be provided with remote alarm indicator. Remote alarm indicator unit shall be mounted on single gang plate and be located in an accessible location for easy viewing and monitoring immediately beneath the duct smoke detector.

C. Intelligent Ceiling Mounted Heat Sensors: Notifier Model FST-951 analog thermal sensors shall be provided where indicated on the Drawings.

1. The intelligent thermal sensors shall connect via two wires to one of the intelligent control panel loops.

2. The sensors shall use dual electronic thermostats to measure temperature levels in its chamber and shall, on command from the control panel, send data to the panel representing the analog temperature level.

3. The sensors/control panel shall provide a test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the sensor itself, by activating a magnetic switch, or may be activated remotely on command from the control panel.

4. The sensors shall provide address-setting means on the sensor head using rotary decimal switches. No binary coding shall be required. The sensors shall also store an internal identification code which the control panel shall use to identify the type of detector.

5. The sensors shall provide dual alarm and power/status LEDs. Status LEDs shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

6. The sensor shall be semi-flush ceiling-mounted and be provided with modular detector head with twist-lock base. Sensors shall be provided in smooth white finish.

D. Remote Indicator Stations: Where the smoke sensors are located in concealed locations or locked rooms, a flush ceiling-mounted remote indicator station with visual LED indicator shall be provided for each sensor involved. Ganging of multiple indicators on a single plate will not be acceptable.

2.11 MANUAL STATIONS:

A. Addressable Manual Stations: Notifier Model NBG-12LX semi-flush mounted type manual stations with an addressable interface module or approved equal shall be provided where indicated on the Drawings.

1. The manual station addressable module shall connect with two wires to one of the intelligent control panel loops.

2. The module at the manual station shall, on command from the control panel, send data to the panel representing the state of the manual station switch.
3. The manual station addressable module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required.
4. A LED shall be provided on the addressable module which shall flash under normal conditions, indicating that the manual station is operational and in regular communication with the control panel. The LED may be placed into steady illumination by the control panel, indicating that an alarm condition has been initiated via the station.
5. Provide weather-proof addressable manual stations in areas where the device is subject to rain or moisture.

2.12 INPUT/OUTPUT DEVICES:

A. Monitor Module (Addressable input Device): Notifier Model FMM-101 or approved equal addressable monitor modules shall be provided where required to interface to contact alarm devices.
   1. The monitor module shall be used to connect a supervised zone of conventional initiating devices (any N.O. dry contact device, including 4 wire smoke detectors) to an intelligent loop.
   2. The monitor module will mount in a 4" square electrical box.
   3. The monitor module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required.

B. Control Module (Addressable Output Device): Notifier Model FCM-1 or approved equal control/relay modules shall be provided where required to provide audible alarm interface and/or relay control interface.
   1. The control module shall be used to connect a supervised zone of conventional indicating devices (any 24 volt polarized audiovisual indicating appliance) to an intelligent loop. The zone may be wired Class A or Class B field-selected. The control module may be optionally-wired as dry contact (Form C) relay.
   2. The control module will mount in a standard 4" electrical box.
   3. Power for the relay actuation shall be provided by the intelligent detector loop to reduce wiring connection requirements. Audio/visual power shall be provided by a separate loop from the main control panel or from supervised remote power supplies.
   4. The control module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required. A status LED shall be provided which shall flash under normal conditions, indicating that the control module is

operational and in regular communication with the control panel. The LED shall illuminate steady when the device is actuated via the Fire Alarm Control Panel.

C. Auxiliary Control Relays: Notifier MR-101/C or approved equal relays shall be provided for control interface. Relays shall be heavy duty type and rated up to 20 amps at 120 volts ac, 60 Hz. Relays shall be provided with NEMA 1 dust cover assembly and be provided with DPDT contacts.

D. Sprinkler Waterflow and Pressure Switches: Switches shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor.

E. Fire Protection OS&Y Valve Supervisory Switches: Switches shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor. Switches shall activate a supervisory signal within two turns of the valve or more than 1/3 of the valve travel toward the closed position.

F. Magnetic Door Holders: Notifier Model DH Series or approved equal low profile 24 volt wall or floor mounted electromagnetic door hold opens as required to suit installation requirements. Magnetic door hold opens shall be powered from the fire alarm system.

2.13 ALARM SIGNAL DEVICES:

A. Ceiling Mounted Fire Alarm Speakers in Finished Areas: Notifier “L” Series or equal flush mounted fire alarm speakers shall be provided.

1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.

2. Speakers shall be 4" round with textured white decorative metal grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.

3. Speakers shall be ceiling mounted and located as required by Section 403 of the international Building Code and as located on the drawings.

B. Ceiling Mounted Fire Alarm Speakers/Visual Signals in Finished Areas: Notifier “L” Series flush mounted fire alarm speakers with integral visual alarm signals or equal shall be provided.

1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.

2. Speakers shall be 4" round with white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.

3. Speakers shall be ceiling mounted and located as required by Section 403 of the international Building Code, and as located on the drawings.
4. Visual alarm signals shall be integral with audible alarm device where shown on the drawings. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed.
5. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals. Each unit shall produce a minimum of 15 candela and have a selectable switch to change the candela rating of the device.
6. Visual devices shall be synchronized.

C. Ceiling Mounted Fire Alarm Visual Signals in Finished Areas: Notifier “L” Series flush mounted fire alarm visual alarm signals or equal shall be provided.
   1. Strobe lights shall be listed under UL Standard 1971and meet all specifications of the Life Safety Code.
   2. Strobes lights shall be 4" square with white decorative grill.
   3. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed.
   4. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals. Each unit shall produce a minimum of 15 candela and have a selectable switch of change the candela rating of the device.
   5. Visual signals shall be synchronized.

D. Weather-Proof Fire Alarm Speakers/Visual Signals in Finished Areas: Notifier “LK” Series flush mounted fire alarm speakers with integral visual alarm signals or equal shall be provided where devices are exposed to rain or humidity.
   1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.
   2. Speakers shall be 4" round with white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.
   3. Speakers shall be ceiling mounted and located as required by Section 403 of the international Building Code, and as located on the drawingsVisual alarm signals shall be integral with audible alarm device where shown on the drawings. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed.

4. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals. Each unit shall produce a minimum of 15 candela and have a selectable switch of change the candela rating of the device.
5. Visual devices shall be synchronized.
6. A weather proof back box shall be provided with each device.

E. Wall Mounted Fire Alarm Speakers/Visual Signals in Unfinished Areas: Notifier “L” Series recess/surface mounted fire alarm speakers with integral visual signals or equal shall be provided.

1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.
2. Speakers shall be 4" round with textured white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.
3. Speakers shall be ceiling mounted and located as required by Section 1807 of the Uniform Building Code and as located on the Drawings.
4. Visual alarm signals shall be integral with audible alarm device where shown on the Drawings. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed.
5. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals. Each unit shall produce a minimum of 15 candela and have a selectable switch of change the candela rating of the device.
6. Visual devices shall be synchronized.

F. Remote Strobe Light Power Supplies: Notifier FCPS-24S6 power or equal shall be provided.

1. Each power supply shall be equipped with four NAC circuits.
2. Each power supply shall be provided with an integral battery backup system.
3. A dedicated 120 VAC emergency power circuit shall be provided by the Electrical Contractor. No more than 3 power supplies shall be connected to one 120 VAC circuit.
4. Each power supply shall provide synchronization signals for all visual devices connected to it.

2.14 SYSTEM WIRING:

A. The equipment supplier shall furnish to the installing contractor a complete detailed point-to-point wiring diagram showing the system equipment and required number, type and sizes of conductors and conduit sizes. Where common devices which break the alarm circuit are installed on a common zone with shorting type device, the circuit breaking devices shall be wired electrically downstream of the shorting type devices.

B. All fire alarm system wiring [which is exposed, concealed in inaccessible locations, wired between floors or wired between building smoke compartments] shall be installed in an approved raceway. [Fire alarm wiring routed horizontally in concealed accessible locations may be installed using approved plenum rated fire alarm cable.]

C. All fire alarm system wiring shall be multiconductor, UL listed FPL for limited energy (300 volt) and fire alarm applications, and NEC approved fire alarm cable. Wiring shall be installed in accordance with NEC, local codes, Article 760 of NFPA Standard 70, and manufacturer's recommendations. All wiring shall be copper and installed in conduit sized in accordance with the National Electrical Codes. Limited energy FPLP wire may be run open in return air ceiling plenums provided such wire is UL listed to UL TEST 910 for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760-4(d) if so approved by the local authority having jurisdiction.

D. Fire alarm system wiring shall be color coded.

E. All fire alarm system junction boxes including covers, shall be secured, painted red and marked in white lettering as specified in Section 26 05 53, “Identification for Electrical Systems”.

F. Wire size shall be determined by calculated voltage drop and circuit loading. Minimum wire size shall be as follows:

1. #18 AWG twisted and shielded for data and communications circuits.
2. #18 AWG for non-data and communications initiating and low voltage auxiliary control circuits.
3. #16 AWG twisted for alarm circuits.
4. #14 AWG for all power circuits.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Installer shall examine the areas and conditions under which the fire alarm system is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 SYSTEM DESIGN:

A. General: The basic equipment and device locations have been shown on the contract drawings. Specific wiring between equipment/devices has not been shown. It is the contractors responsibility to submit for approval the COMPLETE ENGINEERED system

configuration and layout showing all devices, wiring, conduit, and locations along with other required information as specified herein.

3.3 PROGRAMMING:

A. General: The manufacturer shall provide and install a menu driven software package, and shall provide all required programming of the system, including digitized voice alarms, graphics and action messages. Map and report formatting will be part of the software package. The software programming shall provide clear decision-making displays and text during critical alarm conditions that will allow the operator to make simple decisions during a crisis.

B. Review: A hard copy of all graphic map displays will be presented to the Owner for review. Before the manufacturer loads the program the Owner shall be given the opportunity to review and approve all textural displays, messages and system sequences. After programming is completed the Owner shall be given a demonstration, on a color monitor, of screen displays and sequences under various alarm conditions.

3.4 INSTALLATION:

A. General: Install system and materials in accordance with manufacturer's instructions, roughing-in drawings, and details on the Drawings. Install electrical work and use electrical products complying with the requirements of the applicable Division 26 sections of these Specifications. Mount manual stations and alarm devices at heights specified in Section 26 05 01, "Electrical Basic Materials and Methods".

B. Wiring: All wiring shall be in accordance with NFPA 72, the National Electrical Code, Local Codes, and Article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.

1. Install fire alarm system line voltage and low-voltage wiring in a suitable raceway. Conceal fire alarm system conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.

2. All wiring shall be run in a supervised fashion (i.e. no branch wiring or dog-legged wiring) per NFPA requirements such that any wiring disarrangement will initiate the appropriate trouble signals via the main control panel per NFPA and UL requirements. Intelligent SLC loops may be T-tapped/branch wired due to inherent dynamic supervision.

3. Wiring splices shall be kept to a minimum with required splices to be made in designated terminal boxes or at field device junction boxes. Transposing or color code changes of wiring will not be permitted. End-of-line supervisory devices shall be installed with the last device on the respective circuit. Said device shall be appropriately marked designating it as the terminating device on the respective circuit.

4. No AC wiring or any other wiring shall be run in the same conduit as fire alarm wiring.

5. Number code and color code conductors appropriately and permanently for future identification and servicing of the system.

C. Conduit/Raceway: All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.

1. Conduit and raceway system shall be installed as specified other Sections of the Specifications.
2. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings. Conduit and raceway system shall be installed as specified under the general electrical sections of the specifications and per NEC. Maximum conduit "fill" shall not exceed 40% per NEC.
3. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed and subject to damage.
4. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/ conduit system. All riser boxes shall be adequately sized for the number of conductors transversing the respective box as well as the number of terminations required.

D. Vertical Riser Conduit/Raceway: All vertical/riser wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.

1. Conduit and raceway system shall be installed as specified other Sections of the Specifications.
2. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings. Conduit and raceway system shall be installed as specified under the general electrical sections of the specifications and per NEC. Maximum conduit "fill" shall not exceed 40% per NEC.
3. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/ conduit system. All riser boxes shall be adequately sized for the number of conductors traversing the respective box as well as the number of terminations required.
4. All vertical riser wiring including any (horizontal runs) shall be protected by a 2 hour enclosure. The 2 hour protection of the vertical fire alarm system wiring shall be the responsibility of the Electrical Contractor.

E. Labeling: All system controls, indicators and other devices shall be labeled with names, designations and operating instructions as applicable. Labels shall be either engraved nameplates or covered printed labels and shall be approved by the Engineer. All water flow switches which are hidden shall have identification points. These identification points shall be red tags with white lettering indicating location of the water flow switch. Tag location will be visible from corridors.

F. Checkout: Check wiring to ensure that wiring is in accordance with the system manufacturer's wiring diagrams and that the system is free of open circuits, short circuits, and grounds.

G. Identification: Refer to Section 26 05 53, “Identification of Electrical Systems”, for additional requirements concerning painting, nameplates, and labeling.

3.5 COORDINATION:

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all trades. Adequate coordination shall be provided to ensure proper installation and interface to all peripheral items required to interact with the fire alarm to provide a complete and functional life safety system.

B. The installing contractor shall be fully responsible for coordinating all system and device messages and system operation with the Owner's Representatives and Operating Personnel.

3.6 SYSTEM CHECKOUT AND TEST:

A. All final control panel connections shall be made by a state licensed, factory-trained technical representative of the manufacturer and who shall supervise a System Checkout and Test to demonstrate and confirm to the Engineer, Owner's Representative and the fire department, that the fire alarm system is 100% operational upon completion of the installation, and that it complies with all local code requirements and these specifications. It is intended that the System Checkout and Test be followed by a continuing program of inspection testing and maintenance. The Contractor shall provide a proposal to the Owner for a Maintenance, Inspection and Quarterly Testing Contract in compliance with NFPA 72H, upon completion and system checkout.

B. The System Checkout and Test shall be performed within 30 days after the fire alarm installation and all peripheral systems are completed. The System Checkout and Test shall be performed by a minimum of two licensed fire alarm system technicians, one of which is licensed by the State of Texas, and acceptable to the Engineer and the authority having jurisdiction. The test shall be performed in two parts and two-way radios for use by the test observers shall be provided. The first part shall be a full dry-run test with all subcontractors present, but without the Owner's Representative or fire department present. After the dry-run test is successfully completed, then the final test with the Owner's Representative and fire department present shall be performed.

C. This Contractor shall coordinate the test schedule with all necessary parties and subcontractors required to be present for a complete and functional test.

D. The System Checkout and Test which is a comprehensive 100% inspection and test of all fire alarm system equipment and shall include, but not be limited to the following:

1. Fire Alarm Control Equipment:

a. A visual and functional test of all fire alarm control and auxiliary control equipment.

b. A visual inspection shall be conducted to establish that all electrical connections and equipment as required are properly installed and operating.

c. A remote functional fault simulation test shall be conducted on all relevant field wiring terminations to ensure that all wiring is properly supervised as required.

d. All indicators shall be tested to ensure proper function and operation.

e. All device messages shall be verified to be correct, as installed.

f. All system auxiliary functions including, but not limited to, CPU reporting, elevator recall, fire/ smoke door and shutter control, security interface, HVAC equipment control and shutdown, smoke control initiation, and other specified control functions shall be functionally tested to verify proper operation and proper system messages.

g. Control panel supervisory and alarm current readings shall be taken to verify that the control panel has the appropriate power supplies and standby batteries to operate the system as required. A 3 minute general alarm stress test both under ac power and standby power shall be conducted to further ensure complete operation of the system.

h. The Voice Communication System shall be visually and functionally tested to verify proper operation. Voice paging zoning shall be verified and automatic and manual operation of the voice paging system shall be fully verified. Self-monitoring functions of the voice paging system shall be verified.

i. The firefighters' HVAC system override panel shall be 100% functionally tested to verify that all control switches and indicators function as specified.

2. Annunciators: All annunciators shall be tested to ensure that each point activates properly and labeling correctly defines the area of alarm.

3. Fire Alarm Peripheral Devices: All fire alarm peripheral devices shall be functionally tested and the location and testing information recorded for each device.

4. Initiating Devices (Manual and Automatic):

   a. All manual and automatic initiating devices shall be inspected to ensure proper placement and mounting as recommended by the manufacturer and as indicated in these specifications.

   b. All manual fire alarm stations and all automatic initiating devices (smoke detectors, heat detectors, waterflow switches, etc.) shall be functionally tested for alarm operation.

   c. A minimum of 10% of initiating devices shall be functionally tested for proper wiring supervision. Failure of any tested device on any zone shall require that all devices in that zone shall be tested for supervision.

   d. All device messages shall be verified to be correct as installed.

5. Alarm Signaling Devices:

a. All visual alarm indicators and exit sign flashing shall be functionally tested to ensure proper operation and that they are clearly visible.

b. Alarm signaling devices shall be field-checked and tested for proper operation and output.

c. Decibel reading shall be taken to ensure that the alarm signal level can be clearly heard in all areas of the facility, if required by the authority having jurisdiction. Additional devices may be required to provide adequate sound penetration (or as required by the local authority having jurisdiction). Contractor shall provide a unit price for such devices should they be required.

d. A minimum of 10% of the alarm signaling device shall be functionally tested for proper wiring supervision.

6. Reporting:

a. Upon completion of the 100% System Checkout and Test, four copies of the final report shall be documented, certified, and sent to the Engineer for distribution to the Owner or authorized Owner's Representative indicating that all fire alarm equipment has been tested and is 100% operational.

b. The final report shall be generated by the equipment manufacturers headquarters or authorized representative to ensure integrity and uniformity of all testing procedures and reporting. The report shall contain the testing information, stating the precise location and operational status of each and every peripheral device and shall include a Fire Alarm System Certification and Description Document per NFPA 72.

c. The 100% System Checkout and Test shall be performed by factory-trained representatives, and one of the individuals shall possess a state license for fire alarm installation supervision.

3.7 TRAINING:

A. Upon completion of the installation, the equipment manufacturer shall furnish his services for a period of 4 hours of demonstration and training in the use of the system and its connected equipment. The 4 hour training period shall consist of operations and trouble shooting and technical trouble shooting of the fire alarm panel and system. All training shall be provided at the site.

3.8 AS-BUILT/RECORD DRAWINGS:

A. Two sets of manuals and as-built drawings shall be provided by the Contractor. The as-built drawings shall include a reproducible drawing and two copies of each as-built drawing. The drawings and manuals shall be used in the training sessions. At this time, manuals describing the system equipment, as-built wiring diagrams, system keys, and certification of a 100% system audit will be delivered to the Owner. Record drawings shall include, but not be limited to:

1. As-built wiring and conduit layout diagrams incorporating wire color code and/or label numbers and showing all interconnections in the system.
2. Actual locations of each input and output circuit termination, the identification marking of each circuit and the address of each device. Provide an input/output assignment chart. A unique identification number shall be assigned to each alarm initiating device. Identification should be by zone number permanently mounted adjacent to the device or its mounting base. Markings with felt tip pens will not be acceptable.
3. As-built schematic wiring diagrams of all control panels, modules, annunciators and communications panels.
4. As-built heat and smoke detector location drawings showing location dimension of each detector and alarm box.
5. Copies of the manufacturers technical literature on all major parts of the system including detectors, manual stations, signaling appliances, alarm panels. communication panels and equipment and power supplies.
6. Completed Fire Alarm System Certification and Description Document.

B. Refer to Section 26 00 01, “Electrical General Provisions”, for additional As-Built/Record Drawings requirements.

3.9 OPERATING AND MAINTENANCE DATA:

A. The manufacturer's authorized representative shall instruct the Owner's designated employees in the proper operation of the system and all required periodic maintenance. This instruction will include three copies of a written summary in booklet or binder form so employees can retain for future reference. Basic operating instructions for the system shall be framed and mounted at the main control unit. Refer to Section 26 00 01, “Electrical General Provisions”, for additional requirements.

3.10 WARRANTY:

A. The fire alarm and security systems shall be warranted against defects in workmanship and materials, under normal use and service, for a period of [2 years] [one year] from the date of acceptance by the Owner. Any equipment shown to be defective shall be repaired, replaced or adjusted free of charge.

B. The warranty period shall begin after successful completion of the Owner's inspections and tests. In the event of any system malfunctions or nuisance alarms, the Contractor will take appropriate corrective action. This action may necessitate a repeat of the response test if the Owner so desires. Continued improper performance during warranty shall be cause to require the Contractor to remove the system.

C. The warranty start date will not begin until after a period of 30 consecutive days of system operation without any nuisance alarms caused by malfunctioning of hardware of software.

END OF SECTION 28 31 03

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Removal of underground utilities is included in Division 22 and Division 26 Sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses and.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks, pavements.
5. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of [washed]crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing." during earthwork operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 12 inches (300 mm) each side of pipe or conduit or as indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material, 4 inches (100 mm) deeper elsewhere, to allow for bedding course.

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete”.

D. Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.14 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Shape subbase and base course to required crown elevations and cross-slope grades.
2. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.15 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 312000

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

3.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:

1. Division 01 Section Construction Progress Documentation for recording preexisting conditions and excavation support and protection system progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
3. Division 31 Section "Dewatering" for dewatering system for excavations.

3.3 PERFORMANCE REQUIREMENTS

A. Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

3.4 SUBMITTALS

A. Shop Drawings: For excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Other Informational Submittals:

1. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

3.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

a. Geotechnical report.
b. Existing utilities and subsurface conditions.
c. Proposed excavations.
d. Proposed equipment.
e. Monitoring of excavation support and protection system.
f. Working area location and stability.
g. Coordination with waterproofing.
h. Abandonment or removal of excavation support and protection system.

3.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is referenced elsewhere in the Project Manual.

PART 2 - PRODUCTS

3.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTMA36.

C. Steel Sheet Piling: ASTMA328; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

F. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

G. Tiebacks: Steel bars, ASTM A 722/A 722M.

H. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic

pressures.

3.4 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION